NATIONAL MARROW DONOR PROGRAM®

BE THE MATCH®

October 02, 2015

LCDR Christopher Steele
Office of Naval Research
Code 34 – Warfighter Performance
875 N. Randolph St.
Arlington, VA 22203-1995

Subject: **Final Technical Report of the National Marrow Donor Program®**

Reference: Grant Award #N00014-12-1-0142 between the Office of Naval Research and the National Marrow Donor Program

Dear LCDR. Steele:

Enclosed is subject document which provides the performance activity for each statement of work task item of the above reference for the period of December 1, 2011 to September 30, 2013.

Should you have any questions as to the scientific content of the tasks and the performance activity of this progress report, you may contact our Chief Medical Officer – Dennis L Confer, MD directly at 612-362-3425.

With this submission all required closeout activities have been completed by the National Marrow Donor Program and the subject Grant is considered closed.

Please direct any questions pertaining to the Grant to my attention at 612-362-3403 or at cabler@nmdp.org.

Sincerely,

Carla Abler-Erickson

Carla Abler-Erickson, MA
Contracts Manager

Enclosure: Final Technical Report with SF298

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14. ABSTRACT

1. Contingency Prepardness: Collect information from transplant centers, build awareness of the Transplant Center Contingency Planning Committee and educate the transplant community about the critical importance of establishing a nationwide contingency response plan.

2. Rapid Identification of Matched Donors : Increase operational efficiencies that accelerate the search process and increase patient access are key to preparedness in a contingency event.

3. Immunogenetic Studies: Increase understanding of the immunologic factors important in HSC transplantation.

4. Clinical Research in Transplantation: Create a platform that facilitates multicenter collaboration and data management.

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National Marrow Donor Program® N00014-12-1-0142
HLA Typing for Bone Marrow Transplantation
FINAL REPORT
December 1, 2011 – September 30, 2013

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ACRONYM LIST

AABB	American Association of Blood Banks
AAFA	African American (NMDP race code)
AAR/IP	After Action Review/Improvement Plan
ABA	American Burn Association
ABD	Antigen Binding Domain
ABMTR	Autologous Blood and Marrow Transplant Registry
AC	Apheresis Center
AFA	African American
AFB	African
AFRRI	Armed Forces Radiobiology Research Institute
AGNIS®	A Growable Network Information System
AHA	American Hospital Association
AIM	Ancestry Informative Markers
AINDI	South Asian
AISC	American Indian South or Central
ALANAM	Alaska Native or Aleut
ALDH	Aldehyde Dehydrogenase
ALDHbr	Aldehyde Dehydrogenase bright
AMIND	North American Indian
AML	Acute Myelogenous Leukemia
AMR	American Indian
ANSI	American National Standards Institute
API	Asian Pacific Islander
AQP	Ancestry Questionnaire Project
ARC GIS	ArcGIS is a brand name: GIS = Geographical Information System
ARRA	The American Recovery and Reinvestment Act of 2009
ARS	Acute Radiation Syndrome (also known as Acute Radiation Sickness)
ARS	Antigen Recognition Site
ASBMT	American Society for Blood and Marrow Transplantation
ASEATTA	Australian and South East Asian Tissue Typing Association
ASH	American Society for Histocompatibility
ASHG	American Society of Human Genetics
ASHI	American Society for Histocompatibility and Immunogenetics
ASI	Asian American
ASPR	Assistant Secretary for Preparedness and Response
ASTHO	Association of State and Territorial Health Officials
AUC	Area Under Curve
B-LCLs	B-Lymphocytic Cell Lines
B2B	Business to Business
BAA	Broad Agency Announcement
BARDA	Biomedical Advanced Research and Development Authority

BBMT	Biology of Blood and Marrow Transplantation
BCP	Business Continuity Planning
BCPeX	Business Continuity Plan Exercise
BGI	Beijing Genome Institute
BISC	Bioinformatics Integration Support Contract
BM	Bone Marrow
BMCC	Bone Marrow Coordinating Center
BMDW	Bone Marrow Donors Worldwide
BMT	Bone Marrow Transplant/Transplantation
BMT CTN	Blood and Marrow Transplant - Clinical Trials Network
BODI	Business Objects Data Integrator
BRAGG	Bioinformatics Research Advisory Ginger Group
BRIDG	Biomedical Research Integrated Domain Group
BRT	Basic Radiation Training
caBIG	NIH/NCI Cancer Biomedical Informatics Grid
caDSR	Cancer Data Standards Repository
C&A	Certification and Accreditation
CAP	College of American Pathologists
CARB	Black Caribbean
CARHIS	Caribbean Hispanic
CARIBI	Caribbean Indian
CATI	Computer Assisted Telephone Interviewing
CAU	Caucasian
C&A	Certification and Accreditation
CB	Cord Blood
CBAG	Cord Blood Advisory Group
CBITT	Center for Biomedical Informatics and Information Technology
CBMTG	Canadian Blood and Marrow Transplant Group
CBB	Cord Blood Bank
CBC	Congressional Black Caucus
CBS	Canadian Blood Service
CBT	Cord Blood Transplantation
CBU	Cord Blood Unit
CC	Collection Center
CCD	Continuity of Care Document
CDA	Clinical Document Architecture
CDC	Centers for Disease Control
CFU	Colony Forming Unit
CDE	Common Data Elements
CDISC	Clinical Data Interchange Standards Consortium
CEM	Certified Emergency Manager
CEO	Chief Executive Officer

CFO	Chief Financial Officer
CEP	Collect Eject Protect
CFU	Colony Forming Unit
CG-WG	Clinical Genomics Work Group
cGy	CentiGrey
CHORI	Children's Hospital of Oakland Research Institute
CHOP	The Children's Hospital of Philadelphia
CHS	Certified Histocompatibility Specialist
CHTC	Certified Hematopoeitic Transplant Coordinator
CIBMTR®	Center for International Blood & Marrow Transplant Research
CIO	Chief Information Officer
CIT	CIBMTR Information Technology
CLIA	Clinical Laboratory Improvement Amendment
CMCR	Centers for Medical Countermeasures Against Radiation
CMDP	China Marrow Donor Program
CME	Continuing Medical Education
CMF	Community Matching Funds
CML	Chronic Myelogenous Leukemia
CMO	Chief Medical Officer
CMS	Center for Medicare and Medicaid Services
CMV	Cytomegalovirus
COG	Children's Oncology Group
CPI	Continuous Process Improvement
CREG	Cross Reactive Groups
CRF	Case Report Forms
CRID	CIBMTR Recipient ID
CRIS	Computerized Repository Inventory System
CRO	Chief Recruitment Officer
CSF	Colony Stimulating Factors
CSO	Chief Strategy Officer
CSS	Center Support Services
CSS	Custom Search Support
CT	Confirmatory Testing
CTA	Clinical Trial Application
CTLp	Cytotoxic T Lymphocyte Precursor
CTMS	Clinical Trial Management System
CUPC	Cisco Unified Personal Communicator
CV	Co-efficient of Variations
CWD	Common Well Documented
DAIT	Division of Allergy, Immunology, and Transplantation
DaSH	Data Standards Hackathon
DC	Donor Center

DCAA	Defense Contract Audit Agency
DFCI	Dana-Farber Cancer Institute
DHHS	Department of Health and Human Services
DIY	Do It Yourself
DKMS	Deutsche Knochenmarkspenderdatei
DMSO	Dimethylsulphoxide
DNA	Deoxyribonucleic Acid
DoD	Department of Defense
DOE	Department of Energy
DQ	Data Quality
DR	Disaster Recovery
D/R	Donor/Recipient
DRPP	Donor Related Pair Project
DSA	Donor specific anti-HLA antibody
DSMB	Data Safety Monitoring Board
DSTU	Draft Standard for Trial Use
DVD	Digital Video Disc
EBMT	European Group for Blood and Marrow Transplantation
EC	Ethics Committee
ED	Emergency Department
EDC	Electronic Data Capture
EFI	European Federation for Immunogenetics
EHR	Electronic Health Record
ELISA	Enzyme-linked Immunosorbant Assay
ELIspot	Enzyme-linked Immunosorbent Spot
EM	Expectation Maximization
EMDIS	European Marrow Donor Information System
EMR	Electronic Medical Records
ENS	Emergency Notification System
ERSI	Environment Remote Sensing Institute
ESRI	Environmental Systems Research Institute
EUR	European American
E-utilities	Entrez Programming Utilities
FACS	Fluorescent Activated Cell Sorting
FBI	Federal Bureau of Investigation
FDA	Food and Drug Administration
FDR	Fund Drive Request
FGM	France Greffe de Moelle
FHCRC	Fred Hutchinson Cancer Research Center
FHIR	Fast Healthcare Interoperability Resources
FILII	Filipino
FLOCK	Flow Cytometry Analysis Component

FN	FormsNet
FN3	FormsNet3
Fst	Fixation Index
FWA	Federal-wide Assurance
FY	Fiscal Year
GETS	Government Emergency Telecommunications Service
GCSF	Granulocyte-Colony Stimulating Factor (also known as filgrastim)
GDRGEN	Group (HLA)-DR Generic
GETS	Government Emergency Telecommunication Service
GIS	Geographic Information System
GL	Genotype List
GM-CSF	Granulocyte Macrophage Colony Stimulating Factor
GS	General Services
GTR	Genetic Testing Registry
GUI	Graphical User Interface
GVHD	Graft vs. Host Disease
GWAS	Genome Wide Association Studies
Gy	Gray-measure of dose of irradiation
HARPs	HLA Ambiguity Resolution Primers
HAWI	Hawaiian or other Pacific Islander Unspecified
HBCU	Historical Black Colleges and University
HC	Hematopoietic Cell
HCS®	Health Care Standard
HCT	Hematopoietic Cell Transplantation
HEPP	Hospital Emergency Preparedness Program
HHQ	Health History Questionnaire
HHS	Health and Human Services
HIEDFS	HLA Information Exchange Data Format Standards
HIPAA	Health Insurance Portability and Accountability Act
HIS	Hispanic
HIV	Human Immunodeficiency Virus
HLA	Human Leukocyte Antigen
HML	Histoimmunogenetics Mark-up Language
HR	High Resolution
HRSA	Health Resources and Services Administration
HSC	Hematopoietic Stem Cell
HSCT	Hematopoietic Stem Cell Transplant
HSR	Health Services Research
HTML	HyperText Markup Language
HWE	Hardy-Weinberg Equilibrium
IBMDR	Italian Bone Marrow Donor Registry
IBMTR	International Bone Marrow Transplant Registry

IBWC	Immunobiology Working Committee
ICRHER	International Consortium for Research on Health Effects of Radiation
ID	Identification
IDAWG	Immunogenetics Data Analysis Working Group
IDM	Infectious Disease Markers
IDS	Integrated Data Store
Ig	Immunoglobulin
IHIW	International Histocompatibility and Immunogenetics Workshop
IHIWS	International Histocompatibility Work Shop
IHWG	International Histocompatibility Working Group
IIDB	Immunobiology Integration Database
IIMMS	International Immunomics Society
IMGT	ImMunoGeneTics
IMStrategy	Information Management Strategy
ImmPort	Immunology Database and Analysis Portal
IND	Investigational New Drug
IND	Improvised Nuclear Device
IPR	Immunobiology Project Results
IRB	Institutional Review Board
IS	Information Services
ISO	International Organization for Standardization
IT	Information Technology
JAPI	Japanese
JCHO	Joint Commission of Healthcare Organizations
JCAHO	Joint Commission on Accreditation of Healthcare Organizations
KIR	Killer Immunoglobulin-like Receptor
KORI	Korean
LD	Linkage Disequilibrium
LEL	Low Expression Alleles
LSSG	Life Sciences Strategy Group
LTA	Lymphotoxin Alpha
M	Million
MALDI-TOF	Matrix-Assisted Laser Desorption/Ionization – Time Of Flight
MBS	Masters of Biological Science
MCW	Medical College of Wisconsin
MD	Medical Doctor
MDACC	MD Anderson Cancer Center
MDHT	Model Driven Health Tools
MDS	Myelodysplastic Syndrome
MENAFC	MidEast/North Coast of Africa
mHAg	Minor Histocompatibility Antigen
MHC	Major Histocompatibility Complex

MICA	MHC Class I-Like Molecule, Chain A
MICB	MHC Class I-Like Molecule, Chain B
MIRING	Minimal Information for Reporting Immunogenomic NGS Genotyping
MKE	Milwaukee
MLC	Mixed Lymphocyte Culture
MLR	Mixed loss Ratio
MOU	Memorandum of Understanding
MRD	Minimal Residual Disease
MSKCC	Memorial Sloan-Kettering Cancer Center
MSP	Minneapolis
MSWHIS	Mexican or Chicano
MUD	Matched Unrelated Donor
NAC	Nuclear Accident Committee
NACCHO	National Association of County and City Health Officials
NAM	Native American
NAMER	North American
NARR	National Alliance for Radiation Readiness
NCBI	National Center for Biotechnology Information
NCBM	National Conference of Black Mayors
NCHI	Chinese
NCI	National Cancer Institute
NDMS	National Disaster Medical System
NECEP	New England Center for Emergency Preparedness
NEMO	N-locus Expectation-Maximization using Oligonucleotide typing data
NGS	Next Generation Sequencing
NHLBI	National Heart Lung and Blood Institute
NIAID	National Institute of Allergy and Infectious Diseases
NIH	National Institutes of Health
NIMA	Non-inherited maternal antigen
NIMS	National Incident Management System
NK	Natural Killer
NL	Netherlands
NLE	National Level Exercise
NLM	National Library of Medicine
NMDP®	National Marrow Donor Program
NNSA	National Nuclear Security Administration
NRP	National Response Plan
NST	Non-myeloablative Allogeneic Stem Cell Transplantation
NYC	New York City
OB	Obstetrician
OB/GYN	Obstetrics & Gynecology
OCP	Operational Continuity Planning

OCR/ICR	Optical Character Recognition/Intelligent Character Recognition
OHRP	Office of Human Research Protections
OIT	Office of Information Technology
OMB	Office of Management and Budget
ONR	Office of Naval Research
OPA	Office of Patient Advocacy
P2P	Peer-to-Peer
PA	Physicians Assistant
PBMC	Peripheral Blood Mononuclear Cells
PBSC	Peripheral Blood Stem Cell
PCR	Polymerase Chain Reaction
PI	Principle Investigator
POI	Procedures of Interaction
PP	Psudopatient
PSA	Public Service Announcement
PT	Proficiency Testing
QAMS	Quality Assurance Membership Services
QARM	Quality Assurance and Risk Management
QC	Quality control
QR	Quick Response
R&D	Research and Development
RCC	Renal Cell Carcinoma
RCI	Resource for Clinical Investigations
RCI BMT	Resource for Clinical Investigations in Blood and Marrow Transplantation
RD Safe	Related Donor Safety
REAC/TS	Radiation Emergency Assistance Center/Training Site
REDMO	Spanish Bone Marrow Donor Registry
REMM	Radiation Event Medical Management
REMPAN	Radiation Emergency Medical Preparedness and Assistance
REST	Representational State Transfer
RFA	Request for Application
RFP	Request for Proposal
RFQ	Request for Quotation
RG	Recruitment Group
Rh	Rhesus
RITN	Radiation Injury Treatment Network
ROC	Receiver Operating Characteristics
RT-PCR	Reverse Transcriptase-Polymerase Chain Reaction
SAA	Severe Aplastic Anemia
SAP	Single Amino-Acid Polymorphisms
SBT	Sequence Based Typing
SCAHIS	South/Central American Hispanic

SCAMB	Black South or Central America
SCD	Sickle Cell Disease
SCSEAI	Southeast Asian
SCT	Stem Cell Transplantation
SCTOD	Stem Cell Therapeutics Outcome Database
SEARCH	Page 10
SFVT	Sequence Feature Variant Type
SG	Sample Group
SHF	Synthetic Haplotype Frequency
SIRE	Self Identified Race and Ethnicity
SLCBB	St. Louis Cord Blood Bank
SLW	STAR Link® Web
SNP	Single Nucleotide Polymorphism
SNS	Strategic National Stockpile
SOA	Service Oriented Architecture
SOP	Standard Operating Procedure
SQL	Structured Query Language
SRA	Sequence Read Archive
SRB	Survey Research Group
SRG	Survey Research Group
SSA	Search Strategy Advice
SSO	Sequence Specific Oligonucleotides
SSP	Sequence Specific Primers
SSOP	Sequence Specific Oligonucleotide Probes
SSRS	Sample Storage Research Study
STAR®	Search, Tracking and Registry
SVM	Support Vector Machine
SWOG	Southwest Oncology Group
TBI	Total Body Irradiation
TC	Transplant Center
TCE	T-cell Epitope
TED	Transplant Essential Data
TNC	Total Nucleated Cell
TNCC	Total Nucleated Cell Count
TRM	Transplant Related Mortality
TSA	Transportation Security Agency
TTY	Text Telephone
UCB	Umbilical Cord Blood
UCBT	Umbilical Cord Blood Transplant
UCSF	University of California – San Francisco
UI	User Interface
UML	Unified Modeling Language

UNK	Unkown
URD	Unrelated Registry Donor
US	United States
USID	Unique System Identifier
USIDNet	US Immunodeficiencies Network
USB	Universal Serial Bus
VCF	Variant Cell Format
VIET	Vietnamese
VP	Vice President
VPN	Virtual Private Network
WBMT	Worldwide Network for Bone Marrow Transplantation
WC	Working Committees
WebEOC®	Web-based Emergency Operations Center
WGA	Whole Genome Amplification
WH	White
WHO	World Health Organization
WMDA	World Marrow Donor Association
WU	Work-up
XML	Extensible Markup Language
ZKRD	Zertrales Knochenmarkspender – Register für die Bundesrepublik Deutchland

Executive Summary

In 1986, Congress appropriated funds to begin development of the National Bone Marrow Donor Registry. Today, 27 years later, the National Marrow Donor Program (NMDP), as the contractor for the Registry, has built a racially diverse donor registry of 10.5 million donors, facilitated more than 60,000 hematopoietic stem cell transplants, developed comprehensive research programs to improve post-transplant outcomes, and established a network of transplant centers (TCs) capable of treating casualties resulting from military or terrorist actions, as well as patients suffering from leukemia, aplastic anemia, and other life-threatening diseases.

Contingency Preparedness Planning

This grant funded the continued development of the Radiation Injury Treatment Network® (RITN). The Radiation Injury Treatment Network® that provides comprehensive evaluation and treatment for victims of radiation exposure or other marrow toxic injuries. Many of the casualties with radiation injury will be salvageable but require outpatient and/or inpatient care. Recognizing this, the US National Marrow Donor Program (NMDP), US Navy and American Society for Blood and Marrow Transplantation (ASBMT) collaboratively developed RITN, which is comprised of medical centers with expertise in the management of bone marrow failure, stem cell donor centers, and umbilical cord blood banks across the US.

The goals of RITN are:

1. Develop treatment guidelines for managing hematologic toxicity among victims of radiation exposure
2. Educate health care professionals about pertinent aspects of radiation exposure management,
3. Help coordinate the medical response to radiation events
4. Provide comprehensive evaluation and treatment for victims at participating centers

Funding resulted in the growth of RITN, improved national response capability, and increased visibility within the public health preparedness community. Additionally, RITN continued to educate physicians and medical staff through new RITN-established partnerships with key organizations that are instrumental to a national response to a catastrophic disaster.

The NMDP's organizational resiliency program continued to improve organizational capabilities, showing through exercises that the NMDP is prepared for a catastrophic business interruption.

Rapid Identification of Matched Donors

Published research data have clearly defined the relationship between Human Leukocyte Antigen (HLA) matching and optimal patient outcomes following unrelated adult donor transplantation. Continually working to increase the genetic diversity of the Registry helps to ensure that more patients will be able to locate a suitably matched stem cell product for a transplant**.** During NMDP's 2012 Fiscal Year (10/01/2011-09/30/2012), NMDP donor centers (including DoD) and recruitment groups recruited 240,657 minority race and 268,059 Caucasian donors, which were typed at minimum for HLA-A, B and DRB1. Navy funding contributed to the addition of 171,707 NMDP-recruited donors (excluding DoD). This added a culturally diverse group of new donors to the Registry.

Continued advances in laboratory methods and supporting equipment have positively impacted the level of typing resolution for newly recruited volunteer donors. As of September 2013:

- 100% of new donors received higher than intermediate HLA-A, B, C, DRB1, DQB1 typing
- 37% of new donors also received higher than intermediate HLA-DPB1 typing
- Blinded quality control testing accuracy rate was 99.9%, exceeding the project requirement of $\leq$ 2.0% error rate
- On-time testing completion rate was 98.6%, exceeding the project requirement of a minimum of 90.0% of typing results reported within 14 days of shipment of samples
- The cost of HLA typing continues to decrease as technology improves; as of September 2013, the average price per sample for 5 locus typing (HLA-A, B, C, DRB1, and DQB) was approximately $49.50, compared to $134.75 in 1997 for only 3 locus typing (HLA-A, B and DRB1), which represents a decrease of over 60%

Evaluation of the Suitability of Buccal Swabs continued along 3 lines of investigation:

- Results from the 5-year Sample Storage Research Study will be shared with the scientific community in an oral abstract presentation at the November 2013 ASHI Annual Meeting.
- Frozen buccal swab sample storage studies were initiated. An initial feasibility study found that swabs temporarily stored frozen at -30°C for one week were suitable for high resolution HLA typing. A long-term frozen swab storage study has been designed and will begin sample collection for timepoints to span 40 years.
- Studies using alternate sample collection and storage methods continue (saliva, dried GenTegra DNA, Whole Genone Amplified-DNA).

The NMDP's comprehensive quality control (QC) program has supported the successful increase in the quality of HLA typing received through the contract laboratory network. In addition, this program helps to ensure the accuracy of data obtained from research studies that support abstracts and publications.

- The predominant material for QC samples is derived from NMDP Research Repository samples that are transformed into B-Lymphocytic cell lines (B-LCL) and applied to cotton-tipped swabs for inclusion as blind QC samples.

- Of 127 samples that underwent the cell transformation process, 74 (58%) exhibited negative cell growth. A total of 53 unique buccal B-LCL QC Masters were added to the inventory. As of September 30, 2013, there were 534 QC Masters in active rotation.
- A pilot program was intiated to supplement the blind QC program with a cost-effective alternative QC sample type. Purified genomic DNA absorbed onto cotton-tipped swabs was investigated in 2 phases. In limited testing, this sample type was successful in both the recruitment and customized typing lab settings. Further testing of the purified genomic DNA swabs will continue in a wider framework.

Registry HLA Quality Testing

The NMDP maintains lists of rare alleles as a service to the American Society for Histocompatibility & Immunogenetics (ASHI). These lists are derived from HLA allele-level typings of patients, adult volunteers registered as donors, and cord blood units in the NMDP Registry. This project was expanded to evaluate uncommon alleles with occurrence of less than 1500 reported types in the Be The Match Registry. Seventy-three unique alleles were evaluated and retyped primarily by sequence specific oligionucleotide probes (SSOP) high definition technology to confirm the allele in question. Results of these retyping projects improved the HLA typing accuracy and quality of listed adult volunteers.

Collection of Primary HLA Typing Data

In collaboration with the Bioinformatics Group at Anthony Nolan Trust in London, a new XML export of the IMGT/HLA database was developed. This new data combines the data included in the sequence alignments with the data available in the individual allele reports. This machine-readable format provides a standardised format for importing data from the reference database into local programs. The new XML format enables the identification of regions within the DNA sequence, such as specific exons and introns, and allows reconstruction of the sequence alignments. In addition the collaborative project has developed a suite of tools for importing the data into different database schema for allowing incorporation into different laboratory systems. The XML format and associated tools are available from the hla.alleles.org website.

African American Few 10/10 Matched Donor Study

African American (AFA) patients represent an underserved population of patients seeking an unrelated stem cell transplant in the NMDP Registry. Increased HLA diversity, relatively low AFA donor representation on the registry, compounded with low AFA donor availability results in challenging searches for AFA patients. A study was initiated to evaluate NMDP process interventions for AFA searches, which included proactive HLA expert review of AFA patient searches, proactive donor contact to confirm interest and availability, and proactive donor HLA typing upgrades. Patients were randomly enrolled into one of two arms; 182 had intervention activities performed on the search, while

178 had no intervention. For the 182 patients in the intervention arm, 2473 donors were selected for pre-emptive contact and 591 available donors were HLA typed. Ultimately 217 matched and available donors were sent to transplant centers on behalf of 115 patients.

Rapid identification of potential donors for newly diagnosed AML patients
The Southwest Oncology Group (SWOG) has identified the time from diagnosis of AML to transplant as critical for successful treatment of patients with cytogenetically defined high risk disease. Proceeding to transplant within four months of diagnosis for patients with high risk disease in first chronic remission could potentially improve the overall disease free survival rates. In April 2013 SWOG initiated the clinical trial entitled, "S1203: A Randomized Phase III Study of Standard Cytarabine plus Daunorubicin (7+3) Therapy or Idarubicin with High Dose Cytarabine (IA) versus IA with Vorinostat (IA+V) in Younger Patients with Previously Untreated Acute Myeloid Leukemia (AML)". The study includes a transplant arm for patients diagnosed with high risk cytogenetics following the initiation of induction therapy. NMDP/CIBMTR is supporting the project using grant funds to provide study-specific sample collection kits for all enrolled patients, processing samples, HLA typing patients that are diagnosed as cytogenetic high-risk and generating preliminary search strategy reports to assist in the identification of donors and/or CBUs through the NMDP.

Immunogenetic Research

Donor-Recipient Pair Project
The high resolution HLA typing of paired donor and recipient samples continued to provide substantive data to increase the understanding of the impact of HLA matching on patient outcome. The high-resolution HLA data generated through the project are routinely incorporated into all outcomes analyses performed by the Center for International Blood and Marrow Transplant Research (CIBMTR) to provide the best HLA typing and matching information possible. The project has developed the largest, fully validated pool of unrelated stem cell transplant donor-recipient HLA data in the world and is an unparalleled resource for transplant research. The data generated through the project have had a major impact on the evolution of the NMDP HLA matching requirements. The following typing was completed during the grant period:

- 345 donor/recipient paired HLA and KIR typing results were audited for use in research studies.
- Typing was completed on an additional 297 unrelated donor/recipient pairs and data audit initiated.
- Typing was completed on 168 single cord blood transplants and 33 double cord blood transplants. This was the first set of double cord transplants typed through the project.
- To date over 14,500 pairs have been high resolution typed and over 6000 samples have been typed for presence/absence of 14 KIR loci (2DL1-5, 2DS1-5, 3DL1-3 and 3DS1).

Antigen Recognition Domain Alloreactivity Study

Current HLA matching guidelines for unrelated Hematopoietic Cell Transplantation (HCT) recommend avoidance of mismatches only within the antigen recognition domain (ARD), i.e. exons 2 and 3 for HLA class I and exon 2 for HLA class II. This recommendation is based on the hypothesis that amino acid differences outside the antigen recognition site are not immunogenic. To date analysis on six combinations of four haplotypes with mismatches of DRB1*14:01 and DRB1*14:54 and DRB3*02:01 and 02:02 respectively has been initiated. Preliminary results demonstrated two weakly positive and one positive result. Interestingly all positive results occurred in one direction only, which is DRB1*14:01 / DRB3*02:01 against DRB1*14:54 / DRB3*02:02. Analysis of the class I ARS mismatches was performed. Haplotypes including A*02:01 and 02:09, B*44:02 and 44:27, C*07:01, 07:06 and 07:18 were analyzed and it was determined that the selected pairs did not travel on the same haplotypes.

Genetic Ancestry Outcomes Study

A study protocol was submitted to the CIBMTR Immunobiology Working Committee to study the effect of matched genetic ancestry of donors and patients on transplant outcomes. A pilot group of 376 samples were genotyped using an AIMs panel, including custom assay design, oligo acquisition, assay validation.

The Immunobiology Project Results (IPR) database

The Immunobiology Project Results (IPR) database and its applications allow for storage and analysis of immunogenetic data collected on NMDP research samples. This database has replaced the existing HLA donor/recipient pair's database and facilitates storage and analysis of data from other immunogenetic loci. A new release of the Immunobiology Project Results (IPR) application was promoted to the production environment to support the retrospective donor/recipient pairs HLA and KIR typing projects.

Clinical Research in Transplantation

Resource for Clinical Investigations in Blood and Marrow Transplantation (RCI BMT)

The RCI BMT continued to work towards its goal to provide an avenue for investigators to obtain statistical and data management support for prospective trials and projects in HCT. The following key activities were completed during this grant:

- Clinical Trials Advisory Committee (CTAC) held its annual in-person meeting and a mid-year meeting during this grant period. The annual meeting occurred during the Tandem meetings in February 2012 and the mid-year meeting occurred via conference call in July 2012. This committee has been charged with providing scientific review and recommendations on clinical trial proposals. At its in-person meeting, no proposals were received; however, a review was completed of the current trials and projects being supported by the RCI BMT. At its July 2012 meeting, the committee reviewed two proposals. The CTAC did not approve either proposal,

but provided recommendations to strengthen their projects and invited the proposers to resubmit if interested.

- In September 2011, the adult double cord protocol for patients with hematologic malignancies met its accrual goal of 56 patients. Staff continued working with sites to ensure all data was submitted, data queries were addressed, and performed site monitoring visits during this grant. An abstract was submitted and accepted for oral presentation at the Annual BMT Tandem meetings in February 2013. The following conclusions were presented:
    - Double cord blood transplant is a viable alternative treatment for adults with high-risk acute leukemia/ MDS that extends transplant access to those lacking a matched related or unrelated donor.
    - Early transplant related mortality was high**;** Potential contributors were
        - too liberal organ function & performance status eligibility criteria
        - too low TNC cut-off of 1.5
        - q12 MMF stopping at day 45
    - Chronic GVHD and relapse were low
    - Immune recovery analysis continues however plateau on survival curve suggests immune reconstitution in survivors

- The Long-Term Donor Follow up (LTDFU) study opened October 1, 2010. Accrual to this study includes donors who previously donated (retrospective), in addition to donors who are donating currently (prospective). During this grant, a total of 3380 donors enrolled in this study, bringing the study total to 12,997 donors consented to participate, (3871 prospective and 9126 retrospective).

- In collaboration with other leaders in the field, CIBMTR contributed substantially to the successful research proposal to the CMS to collect outcomes data for myelodysplastic syndrome, to demonstrate benefits of HCT to both survival and quality of life. In order to answer the objectives of this study, comprehensive research data forms are required on all accrued recipients. A system is in place to only select a limited number of these forms for general research purposes due to limited funds. The addition of these forms to the selection criteria does not replace but adds to the required forms and thus the funds required for payments. Form payment for 90 recipients enrolled in this CMS-MDS study were covered during this grant.

Cord Blood Research Activity

The Cord Blood Research subcommittee continued work on several ongoing projects. Testing was completed for the validation phase for the study investigating biomarkers associated with cord blood engraftment in order to ensure the generation of consistent results at both testing sites of Duke and St. Louis Cord Blood Bank (SLCBB). Following several rounds of analysis the study was closed for the following reasons:

- Failure to meet the threshold of acceptable results (inter-laboratory reliability ≥ 80%) in the validation phase and the post validation phase of the study.
- The assay was determined to be tedious and cumbersome by a study participant.
- As a result, a study participant and an external potential participant determined a lack of value in the assay and expressed a lack of interest in continuing any type of optimization.

CBU Release Criteria Study

Work continued on a study to assess CBU characteristics (viability, TNC, CFU and CD34) pre-freeze and post thaw. The study proposal was presented to the Graft Sources and Manipulation Working Committee meeting during Tandem 2013. The committee members assigned a low priority score and were unable to accept the proposal. The study proposal was presented to the Cord Blood Advisory Group in June 2013. The committee members assigned agreed to move forward with the study.A study group was created and work began on protocol development, data submission, and contract creation.

NIMA Analysis

Work began on a non-inherited maternal antigen (NIMA) analysis assessing the effect of high-resolution (HR) HLA typing at A, B, C, DRB1, and DQB1 versus the presence or absence of a NIMA match for recipients of a cord blood transplant.

Observational Research Program

Support of the Observational Research program included statistical hours for managing studies within the Immunobiology (detailed below), GVHD, and Graft Sources Working Committees. During this grant period, staff performed proposal review, protocol development, data preparation, data analysis, and manuscript preparations. Details regarding the Immunobiology activities can be found in IID1.3 below. The GVHD and Graft Sources Working Committees published 5 manuscripts. During the grant period, staff supported progress on over 20 other studies.

CIBMTR Information Technology (CIT) Activity

The foundational work for the FormNet3 electronic CIBMTR forms data capture application was completed for implementation in December 2012. This period was significant to the implementation of the new Form Definition Manager in preparation for the Quality Assurance test phase. This tool provided a non-code rendition of new forms, provided access to curated metadata information and was the mechanism for entering form validation and navigation. An additional technical upgrade was completed on the database to prepare for the FormsNet 3 Recipient release in December 2012.

Some overall benefits of the FormsNet 3 application include:

- Provides greater flexibility to improve data quality and responsiveness to user needs.
- Enhanced performance by improving speed, usability, consistency and usefulness of forms access, user data entry, and validations

- Improved user experience/usability by offering real-time data validations, rules, control of data entry "flow", error handling and messaging, and "smart navigations" (from form-to-form or from field-to-field on the same form), auto population of key fields
- Improved data quality- by enabling data entry to be as easy, consistent, accurate, and fast as possible

Immunobiology Research Program
Grant funds supported significant outreach efforts by the Immunobiology Working Committee (IBWC) leadership to increase exposure for the IBWC to researchers involved in immunobiology and immunogenetics. Support permitted the committee to maintain a strong performance record with 6 abstracts presented, 10 manuscripts published, and 3 manuscripts submitted for publication. The IBWC reviewed and accepted 8 proposals during the BMT Tandem meetings in February 2013. The full IBWC research portfolio and publications are continually updated on the CIBMTR Web site.

END – EXECUTIVE SUMMARY

II.A. Contingency Preparedness – Hypothesis 1:

Recovery of casualties with significant myelosuppression following radiation or chemical exposure will be optimal when care plans are designed and implemented by transplant physicians

Aim A.1.1: Secure Interest of Transplant Physicians

In working to accomplish this Aim, the National Marrow Donor Program (NMDP) focused on the education of physicians, their medical and support staff, as well as partners from the public health emergency preparedness community. This included Advanced Medical Response to Treat Radiological Casualties, the presentation of the standardized Radiation Injury Treatment Network ® (RITN) Acute Radiation Syndrome Grandrounds training for medical staff, the development of web based training, and a conference titled "Mitigation and Treatment of Radiation Damage."

Education of physicians and medical and support staff was accomplished through instructor lead didactic sessions and self guided web based training. Instructor-led training included the RITN Acute Radiation Syndrome Medical Grandrounds and the Advanced Medical Training on Radiation Emergency Medicine course. The Grandrounds training was a standardized class that RITN provided to hospitals for their implementation. Each year, RITN centers have tasks that they must accomplish and these training programs are among the task options. As a result, thousands of hospital staff have attended this training course.

The second instructor-led course is the Advanced Medical Training on Radiation Emergency Medicine course; this course was conducted by staff from the Radiation Emergency Assistance Center and Training Site (REAC/TS) in Oak Ridge, TN. During this period of performance, a mobile course was introduced where the REAC/TS instructors travel to an institution to provide the training. The mobile course option significantly decreased the interruption to medical staff schedules and allows for much larger class sizes (the REAC/TS classroom in TN is limited to 25 students). The first mobile class held at Duke University in August 2012 was attended by over 50 students.

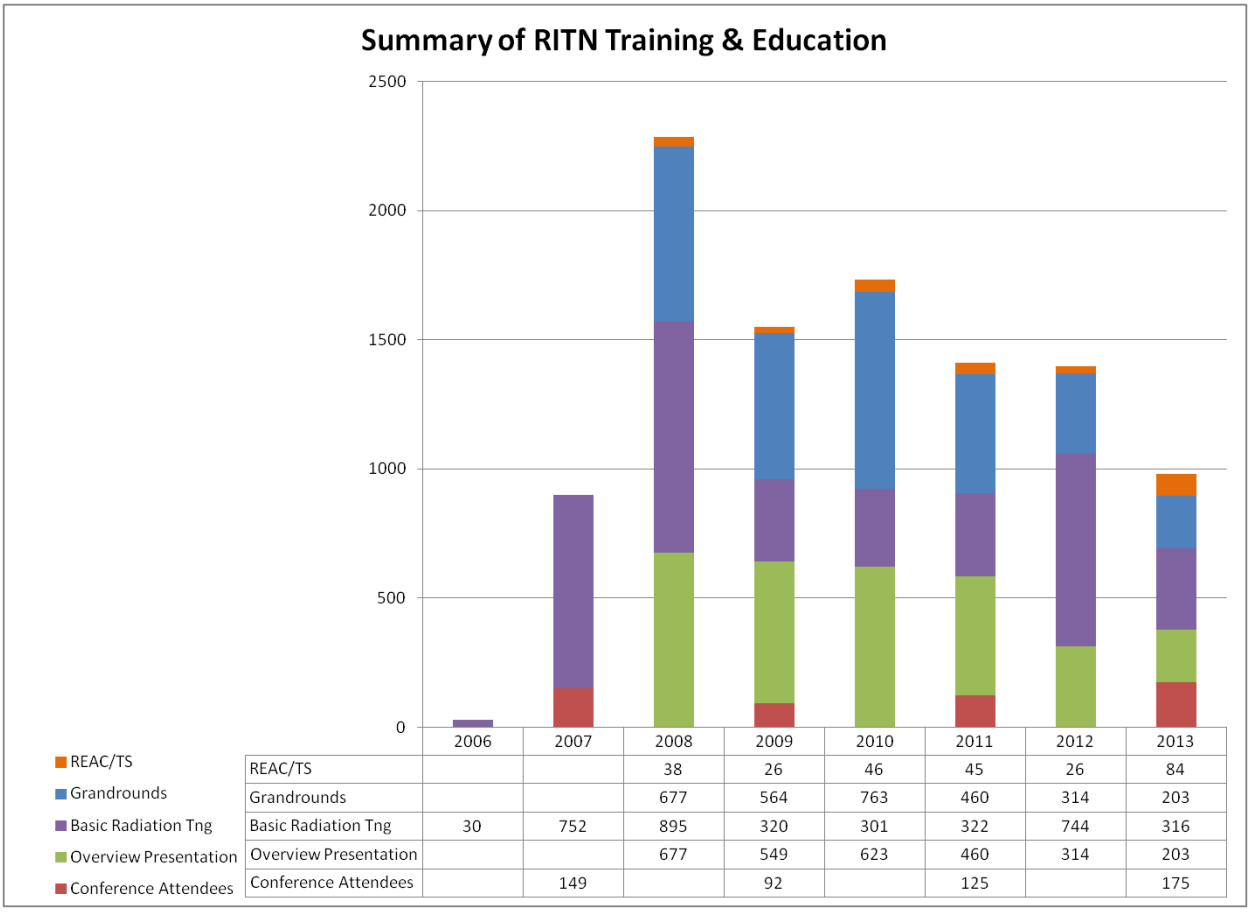
Advanced Medical Training on Radiation Emergency Medicine is a two day course. Attendees earn 14 continuing medical education credits for attending this rigorous course which covers a comprehensive set of topics including:

- Basic Health Physics & Radiation Protection: Part I
- A History of Serious Radiological Incidents: The Real Risk
- Health Physics & Contamination Control: Part II
- Radiation Detection, Monitoring & Protection Laboratory Exercise & Quiz
- Diagnosis & Management of the Acute Radiation Syndrome

- Diagnosis & Management of Internal Contamination
- Diagnosis & Management of Acute Local Radiation Injury & Case Review
- Radiation Sources & Radiological Terrorism
- Radiation Emergency Area Protocol Demonstration
- Radiation Emergency Medical Management Drill
- Radiation Dose Estimations – Problem Solving Session

This grant supported two resident courses at REAC/TS for 44 students and one mobile class for over 50 students.Figure 1 below summarizes the training that RITN has provided or coordinated. Since RITN's inception, 10,293 staff have received training through these sources.

Figure 1. Summary of RITN Training & Education since RITN Inception



	2006	2007	2008	2009	2010	2011	2012	2013
REAC/TS			38	26	46	45	26	84
Grandrounds			677	564	763	460	314	203
Basic Radiation Tng	30	752	895	320	301	322	744	316
Overview Presentation			677	549	623	460	314	203
Conference Attendees		149		92		125		175

To increase the availability of training for the RITN, as well as any organization that has access to the Internet, six web based training courses were developed during this period of performance. The courses provide an overview about RITN, and are accessible from anywhere in the world.

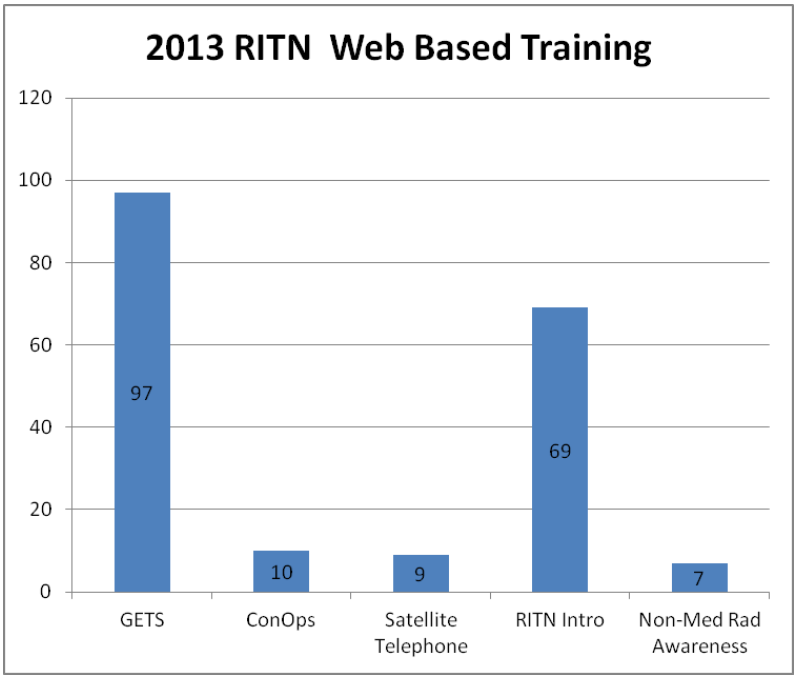
The courses can be taken in succession (the ideal way for new RITN staff to learn what they need to know about their responsibilities related to RITN), or each course can be taken individually. There are no prerequisites to the courses and each is its own stand alone course for trainees. The six courses are:

1. Introduction to the Radiation Injury Treatment Network
2. Radiation Injury Treatment Network Concept of Operations Training
3. Basic Radiation Training
4. Radiation Awareness Training for Non-medical Staff
5. Government Emergency Telecommunications Service User Training
6. Satellite Telephone User Training

Figure 2. Screenshots of the new RITN Training Materials

Adoption of the RITN web based training has been slow and is likely because completion is not mandatory. All of the training options in the Summary of RITN Training and Education figure above (Figure 1) contribute to a RITN center completing its annual tasks, whereas the remaining five courses in Figure 3 below are optional.

Figure 3. RITN Web Based Training



During this period of performance, a conference was held to educate medical staff, researchers, and public health officials entitled "Mitigation and Treatment of Radiation Damage." RITN partnered with the National Institute of Allergy and Infectious Diseases (NIAID) Centers for Medical Countermeasures against Radiation (CMCRs); 175 people attended the conference and rated it highly. *This conference is described in detail under Aim A.2.1.*

Aim A.1.2: GCSF in Radiation Exposure

This Aim focused on non-transplant treatment guidelines and patient assessment related to the use of GCSF for patient treatment as a result of a marrow toxic mass casualty incident such as exposure to ionizing radiation.
Efforts related to this Aim were incorporated into the physician education conducted under AIM A.1.1.

Aim A.1.3: Patient Assessment Guidelines

This Aim focused on the development of transplant treatment guidelines and the associated support systems. This includes the refinement of guidelines for patient assessment, operational and educational aspects of rapid product selection and transplant procedures for management of a marrow toxic mass casualty event.
Efforts related to this Aim were incorporated into the physician education conducted under AIM IIA 1.1, as well as the update of the RITN Acute Radiation Syndrome Treatment Guidelines which is associated with the RITN Medical Advisor efforts under AIM A.2.1.

II.A. Contingency Preparedness – Hypothesis 2:

Coordination of the care of casualties who will require hematopoietic support will be essential in a contingency situation.

Aim A.2.1: Contingency Response Network

The RITN provides comprehensive evaluation and treatment for victims of radiation exposure or other marrow toxic injuries.

In the event of a mass casualty radiation exposure or othe marrow toxic incident many of the casualties with radiation injury will be salvageable, but will require outpatient and/or inpatient care. Recognizing this, the US National Marrow Donor Program (NMDP), US Navy and American Society for Blood and Marrow Transplantation (ASBMT) collaboratively developed RITN, which comprises of medical centers with expertise in the management of bone marrow failure, stem cell donor centers and umbilical cord blood banks across the US.

The goals of RITN are:

1. To develop treatment guidelines for managing hematologic toxicity among victims of radiation exposure,
2. To educate health care professionals about pertinent aspects of radiation exposure management,
3. To help coordinate the medical response to radiation events, and
4. To provide comprehensive evaluation and treatment for victims at participating centers.

During 2012 the RITN grew to include 66 centers comprised of:

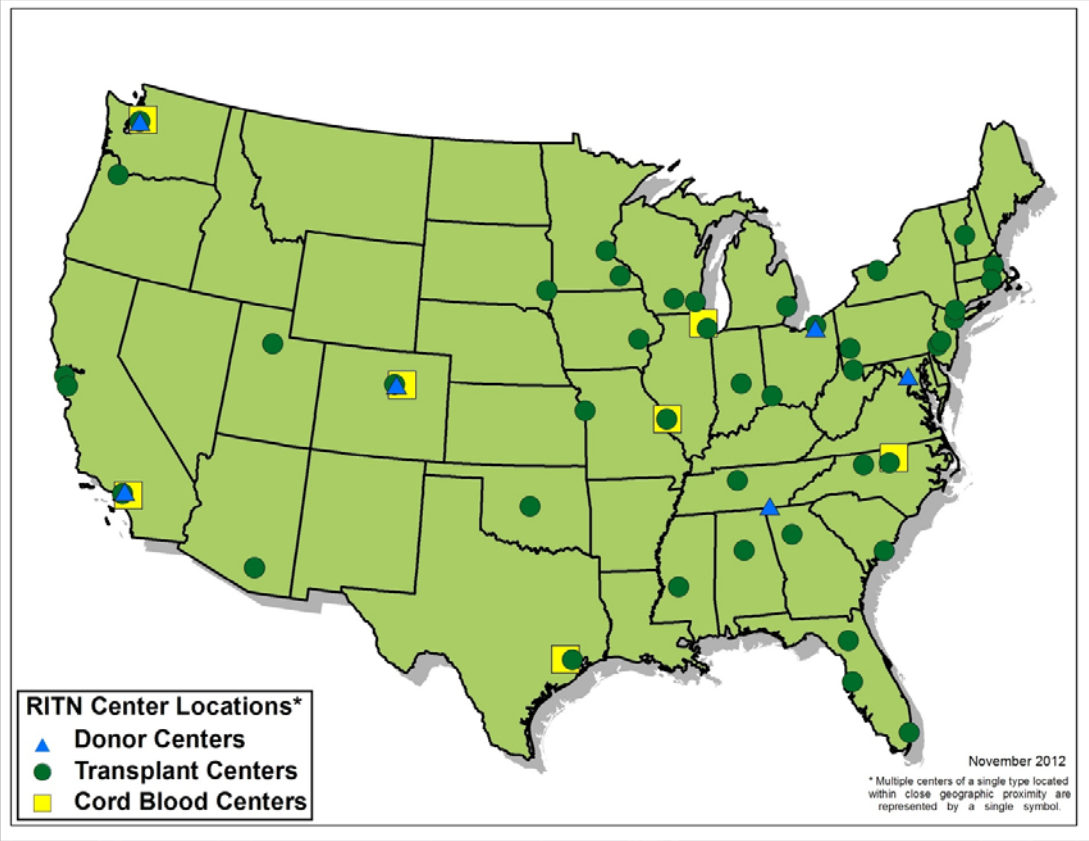
- 53 transplant centers
- 6 donor centers
- 7 cord blood banks

Six hospitals joined RITN during 2012, these included:

1. Primary Children's Medical Center (UT)
2. Massachusetts General Hospital (MA)
3. Zalmen A. Arlin Cancer Institute/Westchester MC (NY)
4. West Virginia University Hospitals, Inc. (WV)
5. Mount Sinai (NY)
6. University of Wisconsin Hospital & Clinics, Madison (WI)

RITN centers are well distributed across the nation as shown in the Figure 4 below.

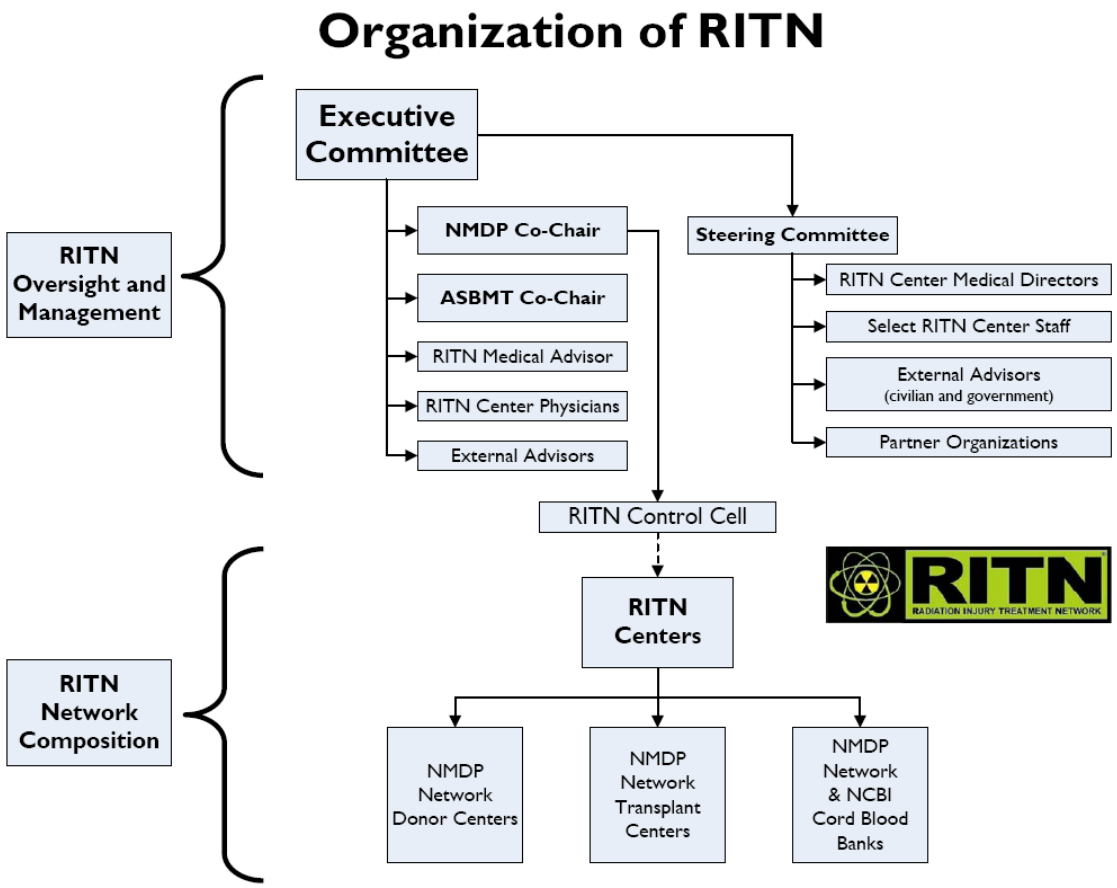
Figure 4. RITN Center Locations in the United States



The RITN is managed by the RITN Executive Committee which develops and/or reviews all RITN materials from the training courses to the treatment guidelines. As part of the Executive Committee the RITN Control Cell interfaces with the network of medical professionals that participate in RITN. A Steering Committee consisting of RITN center staff, federal advisors and partners supports the Executive Committee.

The Executive Committee meets every other month via teleconference and the Steering Committee meets once a year in person at a meeting held during the annual ASBMT/CIBMTR Tandem Conference. Since many members of RITN already regularly attend this annual conference there is a cost savings to hold the Steering Committee meeting at the conference as well as broadcasting the strong relationship between the RITN and ASBMT.

Figure 5. Organization of RITN



The RITN Executive Committee is co-chaired by a representative from the NMDP and from the ASBMT, and assisted by a Medical Advisor, other physicians and technical advisors that support the activities of this committee:

- Committee Chairs:
  - Co-Chair: Dennis Confer, MD
  - Co-Chair: Nelson Chao, MD (ASBMT past President)
- RITN Medical Advisor:
  - David Weinstock, MD
- Committee Members:
  - Transplant Physician: Daniel Weisdorf, MD (ASBMT past President)
  - Transplant Physician: John Chute, MD
  - Transplant Physician: Willis Navarro, MD
  - Emergency medicine physician: David Markenson, MD
  - ASBMT Representative: Julie Wilhauk, ARNP, AOCNP

- ASBMT Representative: Robert Krawisz, MBA
- RITN Program Manager: Cullen Case Jr., CEM

Some of the outcomes Executive Committee conference calls held during this period of performance include:

- Coordination of meetings with BARDA and AHA
- Review of the RITN Concept of Operations
- Review of the member survey
- Review of appropriate marrow toxic data elements for collection following an incident
- Planning for the RITN Conference with the NIAID-CMCRs
- User Managed Inventory proposal review
- Creation of Pediatric Acute Radiation Syndrome (ARS) Treatment Guidelines

Much of the work done in support of the activity reviewed by the RITN Executive Committee can be attributed to the efforts of the RITN Medical Advisor, Dr. David Weinstock. ; During the project period Dr. Weinstock completed the following:

- Authored a chapter on Radiation Emergency Response in the forthcoming: Koenig & Schultz's Disaster Medicine: Comprehensive Principles & Practice textbook
- Co-authored three peer-reviewed manuscripts:
  - a manuscript in press for Leukemia on response to the Fukushima Daiichi nuclear power plant incident
  - a manuscript submitted to Lancet in response to radiation incidents
  - a manuscript entitled, " Medical planning and response for a nuclear detonation: a practical guide.
- Participated in the 2012 update of the RITN Medical Grand Rounds Course, publication of the RITN Concept-of-Operations document and development of the 2012 RITN Table-Top Exercise
- Served as the RITN respresentative separate meetings with BARDA and the American Hospital Association:
- Presented several invited talks:
  - BARDA symposium on blood products in Bethesda, MD November 2012
  - National Burn-bed strategy meeting in March 2012
  - Institutes of Medicine Improvised Nuclear Device Workshop in Washington, DC in January 2013
- Led the RITN effort to secure a contract with BARDA to establish a user managed inventory system at RITN centers; to accomplish the proposal he organized the formation

of a network of 18 RITN centers to participate in a G-CSF user managed inventory program, with a proposal to be submitted to BARDA for funding in 2013

- Updated pediatric and adult template admission orders for casualties of a radiation incident. These are national treatment guidelines for patient management and are posted on the REMM (National Library of Medicine) and RITN websites
- Assisted with the 2012 update of pediatric and adult template admission orders for RITN and the REMM website
- Met with representatives from the Veterans Administration and Department of Health and Human Services to establish links with RITN
- Coordinated a response framework between RITN and REAC/TS for future radiation incidents

During the period of performance, the **Steering Committee** members had two in person meetings:

- February 2012 - ASBMT/CIBMTR Tandem meetings (San Diego, CA)
- February 2013 – ASBMT/CIBMTR Tandem meetings (Salt Lake City, UT)

All RITN center staff and partners are invited to a monthly conference call where updates are provided on current projects and RITN center staff have an opportunity to talk about implementation issues with other RITN centers. As part of this monthly conference call, there is a review of "Rad in the News," a summary of radiological related current events from open source media reports. In addition to these monthly meetings, each December,a RITN Year in Review Webinar is presented, which reviews the year's accomplishments and planned activity for the upcoming year.

RITN Annual Tasks

RITN centers are tasked each year to complete a set of tasks in exchange for a small grant. Centers had to update their standard operating procedures, conduct a tabletop exercise, and conduct training of staff. The specific tasks are detailed below:

TASK 1 – Emergency Communications

- Center must update contact information
- Centers must participate in the monthly RITN conference call
- Perform communications tests as directed by RITN:
  - Test call of the RITN issued Government Emergency Telecommunications Service (GETS) calling card.
  - Test call using the RITN issued satellite telephone to the RITN.
  - Login to the RITN portal for HealthCareStandard (HCS) software and submit a Capabilities report.

TASK 2 - Standard Operating Procedure (SOP) update

- For 2012, transplant centers must incorporate the new SOP template based on the site assessment checklists and submit a copy for review.

TASK 3 – Annual refresher training of key staff

- All Centers must have their RITN Physician, Primary RITN Contact, and Alternate RITN Contact successfully complete the Basic Radiation Training.

TASK 4 – Education of staff or response community

- **Option A -** Present the RITN Overview presentation to the Local Emergency Planning Commission, emergency preparedness group, federal emergency response planning group, county or city emergency managers, a local blood bank, or similar appropriate entity.
- **Option B** – Staff training of NMDP Basic Radiation Training: 20 staff members must successfully complete the Basic Radiation Training course (*any 20 may complete the training this year, this is in addition to the three for Task 3*)**.**
- **Option C -** RITN Grand Rounds presentation to medical staff
- **Option D -** Physician attendance of Advanced Radiation Medical Training at REAC/TS
- **Option E** – Site assessment
    - Assessments review critical areas necessary for responding to a mass casualty incident with marrow toxic injuries. . .
    - Areas include: victim processing, outpatient treatment of victims, inpatient treatment of victims, coordination with region, state, or federal agencies, documentation review

TASK 5 – Participate in RITN directed tabletop exercise

<u>Annual RITN Tabletop Exercise</u>

Each year, one of the tasks is to conduct a tabletop exercise with hospital staff and local/regional public health preparedness officials. The scenario for the 2012 tabletop exercise focused on patient triage and prioritization of care following detonation of a 1kT improvised nuclear device in a distant city. Each hospital was asked to prioritize care for 20 paitents. As part of the exercise, hospitals were given patient profiles for 20 adult or 20 pediatric patients (depending on their patient population). The participantsthen had to triage and determine priority of care using exercise defined scarce resource constraints e.g. participants were told there were less than 20 beds for the 20 casualties.

Table 1. RITN Tabletop Exercises by Year

Year	Situation	Max Victims
2006	Radioactive sources discovered on public train system	650 identified as having some level of ARS. 50 patients to each center
2007	Train derailment spills multiple chemicals, produces vapor cloud which exposes a crowd of 15,000	5,000 (mostly children and senior citizens)
2008	IND was detonated and 300,000 victims were triaged	5,000 victims required RITN assistance
2009	10-kiloton nuclear device detonated in a major metropolitan center	12,000 patients with high radiation dose in the 200-600 rads range. 300 patients to each center
2010	Detonation of a surface burst 10-kiloton nuclear device in major metropolitan center	20,000 patients with high radiation dose in the 200-600 rads range. 500 patients to each center
2011	National Disaster Medical System (NDMS) flow and integration	Not specified
2012	1 kT IND detonated 500 miles away from RITN center, 20 patients to prioritize	20 w/ limited bed availability provided
2013	Radiological Exposure Devices on mass transit at eight metropolitan cities	4,500 across the nation; 300 casualties w/ 80 that have cutaneous ARS and accompanied by 140 family members

The results of each year's tabletop exercise, including each centers response to all of the questions, are posted (in a non-attributable format) on the RITN website: www.RITN.net/exercises/

In addition to the tabletop exercise the grant funded two Web based Tabletop Exercises for RITN centers using the same materials; this allowed the RITN Control Cell staff to lead the exercise.

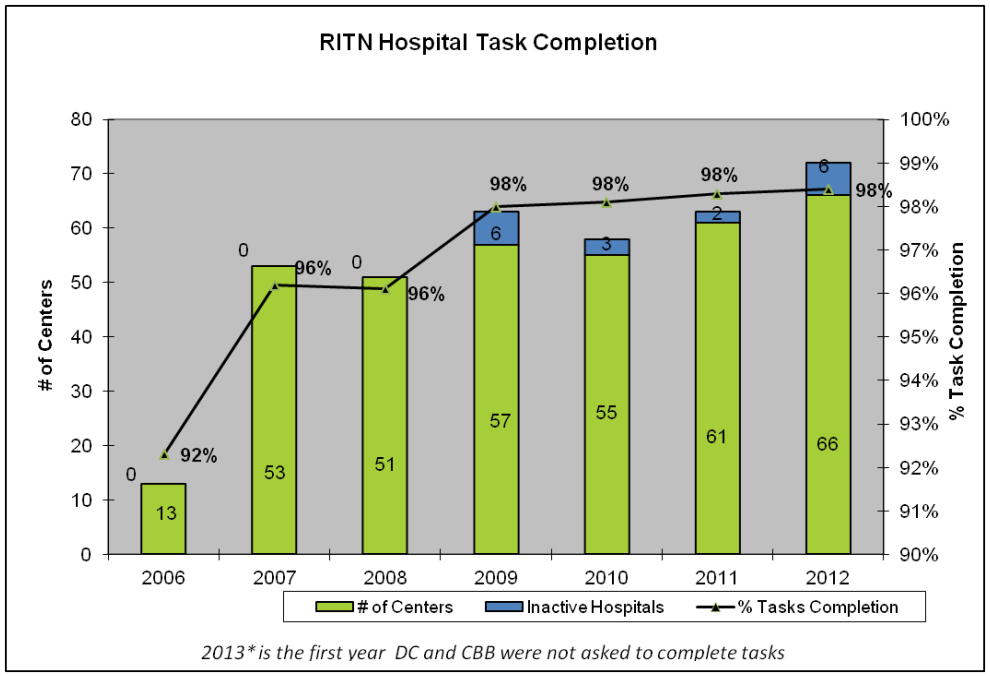
Periodically, RITN Control Cell staff will attend a RITN hospital's tabletop or other exercise to observe. Staff attended the following exercises during the grant period:

- Tabletop exercises atthe University of Wisconsin (Madison), Latter Day Saints and Primary Children's hospitals in Salt Lake City, UT
- Full scale exercise at the Utah Veteran's Administration National Disaster Medical System (NDMS) in Salt Lake City, UT. During the exercise, simulated casualties were triaged and transported by ambulance from the airport to the appropriate RITN hospital for care.

Annual Task Completion

During this grant period, 98% of the RITN centers completed all of their tasks (see Figure 6 below), the same as the previous grant period:

Figure 6. RITN Task Completion by Year



RITN Partnerships

The RITN would not be able to successfully respond to a mass casualty incident without the support of partner organizations. The NMDP has carefully worked to develop and maintain these relationships so that when an event occurs, we have established relationships with these key response organizations.

RITN has two types of relationships: formal relationships documented through a Memorandum of Understanding (MOU) and informal relationships maintained through periodic collaboration.

RITN has established formal partnerships through an MOU with:

- Office of the Assistant Secretary for Preparedness and Response, Department of Health and Human Services (ASPR-DHHS)
- American Society for Blood and Marrow Transplantation (ASBMT)
- American Association of Blood Banks (AABB), through the AABB Inter-organizational Task Force for Disasters and Acts of Terrorism
- New England Center for Emergency Preparedness (NECEP)

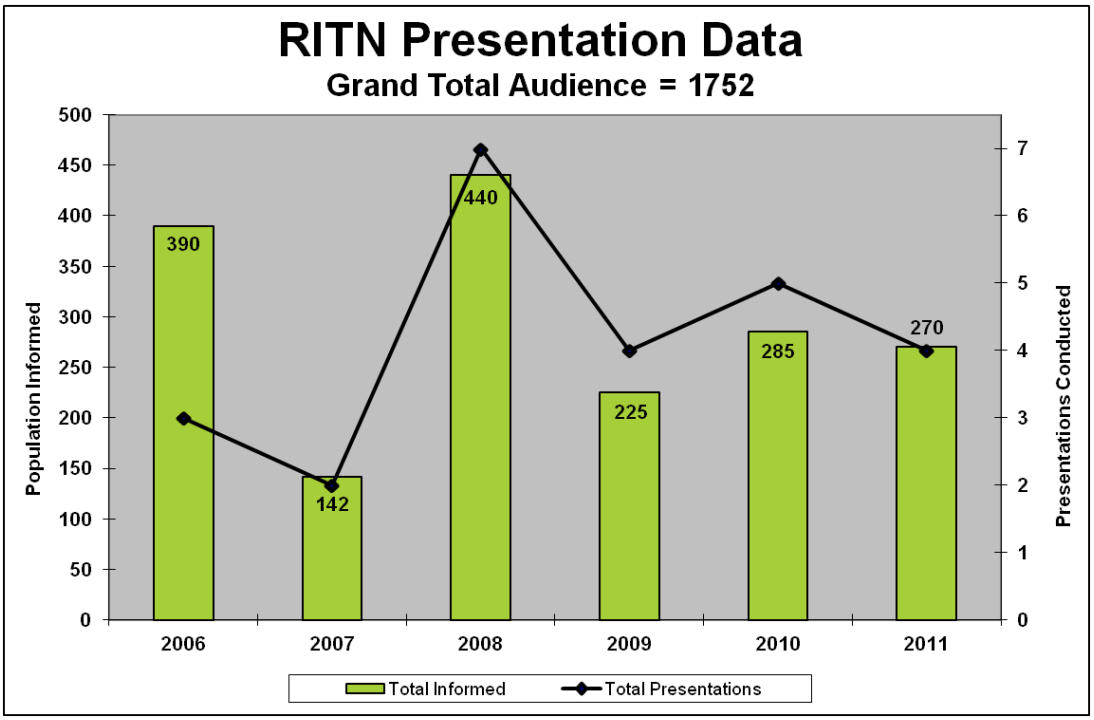
Organizations that RITN has developed informal relationships with include:

- U.S. Department of Veterans Affairs (VA)
- Radiation Countermeasures Centers of Research Excellence (RadCCORE) at Duke University
- The National Institutes of Health, The National Institute of Allergy and Infectious Diseases, Division of Allergy, Immunology and Transplantation (NIH-NAIAD-DAIT)
- Radiation Emergency Medical Management web portal (NIH-NLM-REMM)
- National Cancer Institute's (NCI)
- Biomedical Advanced Research and Development Authority (BARDA)
- European Group for Blood and Marrow Transplantation (EBMT) - Nuclear Accident Committee
- The Radiation Emergency Medical Preparedness and Assistance Network of the World Health Organization (WHO-REMPAN)
- Radiation Emergency Assistance Center and Training Site (REAC/TS)
- American Hospital Association (AHA)
- American Medical Association (AMA)
- National Association of City and County Health Officials (NACCHO)
- Association of State and Territorial Health Officials (ASTHO)

Education and Awareness Training about RITN

To increase the visibility of RITN and make new connections with additional organizations and agencies, overview presentations were given to various professional groups and government agencies. Figure 7 below summarizes the number of presentations given, as well as the size of the audience affected:

Figure 7. RITN Presentations and audience



The RITN and the CMCR convened a three-day workshop on the Mitigation and Treatment of Radiation Damage from July 31st to August 2nd, 2013 that covered topics such as patient assessment, biomarkers and biodosimetry, suitability of animal models, small molecules, growth factors, and cells as mitigators, as well as their mechanisms of action in radiation-damaged tissues, late effects of acute and prolonged exposure, survivorship issues, and future developments. The workshop was held at the Tremont Plaza Hotel in Baltimore, MD.

The purpose of the conference was to provide an open forum for invited and plenary speakers and discussants to assess progress on issues related to radiation injury, mitigation, and treatment. Various radiation scenarios were presented, along with novel approaches at multiple stages of development. The tremendous environmental, social, and medical cost of a large-scale release of nuclear or radiological material as a result of deliberate attack or natural disaster has led to the creation of several programs aimed at improving national and local preparedness.

One hundred and seventy one people attended the conference, of these, 95 attendees completed the evaluation, 27 physicians requested CME credits, and 53 attendees requested contact hours, nursing credits or med tech credits. The conference evaluation results showed the conference to be very successful (ratings were on a scale of 1 to 5, with 5 being best):

- Overall Rating of the Workshop: 4.55
- The information presented applies to my work: 4.45

- The instructional materials helped me to understand the content: 4.10
- The program was well organized: 4.55
- I learned new knowledge & skills from this session: 4.45

The Conference agenda included:

- Keynote Address: Preparedness and Response to Radiation
- Possible Radiological Incident Scenarios
- Casualty Triage and Distribution
- The RITN Response to Radiological Scenarios
- Emergency Management from the CMCR perspective
- Workshop 1: Biodosimetry and Biomarkers - assessing the need
- Animal Models of Radiation Damage and Confounders
- The Challenge underlying Radiation Mitigation
- Workshop 2: Small Molecule Radiation Mitigators
- Workshop 3: Growth Factors and Cytokines as Mitigators
- Workshop 4: Cell Replacement Approaches for Radiation Mitigation
- Workshop 5: Mitigation and Treatment of Late Effects
- Identification of the Grand Challenges in Radiation Mitigation and Treatment

Figure 8. The RITN/CMCR workshop on the Mitigation and Treatment of Radiation Damage

Publications

Another avenue of increasing RITN visibility is through publication in peer reviewed journals. During this grant period, the following articles were published:

1. Coleman CN, Case C Jr, et al. Medical planning and response for a nuclear detonation: a practical guide. Biosecur Bioterror. 2012;10(4):346-71. doi: 10.1089/bsp.2012.1025.
2. Confer DL, Weisdorf D, Weinstock D, Case C, Chao N. Radiation Disasters: Role of the BMT Team. Biol Blood Marrow Transplant. 2012 Jan;18(1 Suppl):S189-92

Figure 9. RITN Acute Radiation Syndrome Treatment Guidelines updated during this period of performance.

Aim A.2.2: Develop and test standard operating procedures, in conjunction with core transplant centers, to manage the activities required to HLA type siblings of casualties to evaluate their potential as HSC donors for their affected family member.

No funding was requested under this Aim for the 0142 budget cycle.

II.A. Contingency Preparedness – Hypothesis 3:

NMDP's critical information technology infrastructure must remain operational during contingency situations that directly affect the Coordinating Center.

Aim A.3.1: Disaster Recovery: Ensure NMDP's ability to access and utilize its information management and communication infrastructure in a contingency situation in which its Minneapolis Coordinating Center is damaged or destroyed.

No funding was requested under this Aim for the 0142 budget cycle.

Aim A.3.2: Operational Continuity Planning:

The focus of this Aim is to improve organizational resiliency to severe business disruptions through Operational Continuity Planning. In the event that the Coordinating Center is not available for an extended period of time, critical tasks will have to be conducted at an alternate location. To meet these needs, the NMDP maintains a formal Operational Continuity Plan (OCP) consisting of documented procedures for guiding the organization to respond, recover, resume and restore to a predefined level of operations following disruptions. In the event that the Coordinating Center is not available for an extended period of time, critical task execution will require use of available non-contracted alternate locations.

The OCP is annually reviewed by key stakeholders to test planned response actions with current operational practices and predefined maximum tolerable periods of disruption (MTPD). MTPD is the time it takes for adverse impacts as a result of not providing services or performing activities to become unacceptable. Inputs for OCP improvement include current operational impact analyses, functional and tabletop exercises, and industry regulatory or standard changes. The OCP is adaptable and enables the organization to respond to a wide range of disruptive incidents, including those the NMDP may not have anticipated. The NMDP's formal OCP is maintained by the Operational Continuity Planner.

During this period of performance, the NMDP conducted a significant exercise to determine the success of remediation of VPN capability identified the previous year. Seventy nine NMDP staff participated by successfully connecting to NMDP information systems via VPN from various remote locations. The exercise included the use of soft telephones through the laptops using Cisco Unified Personal Communicator software and USB headsets. VPN server load capacity appeared adequate to meet the needs of 175 remote users should a severe operational disruption occur. The maximum load capacity used on one VPN server was 23% and 1% of the other. This was a continuation of the annual NMDP Operational Continuity Exercise and past exercises. Results are shown in Table 2 below.

Table 2. Operational Continuity Exercises by year

2012	VPN exercise with 79 simultaneous remote users	-Demonstrated more than adequate capacity for 175 required response staff
2011	Critical Staff Recovery Site at Regus, 80 on-site participants	-95% of tested critical tasks (n=98) successfully accomplished -Successfully used software faxes and soft phones
2010	Critical Staff Recovery Site at Roseville Radisson, 47 on-site participants	-88% of tested critical tasks (n=60) successfully accomplished -Successfully used analog faxes and soft phones
2009	Critical Staff Recovery Site at Ramada Plaza Hotel, 23 on-site participants	-92% of tested critical tasks (n=33) successfully accomplished -Successfully used desktop phones

RSA secure tokens were purchased to support increased information system access of identified Operational Continuity Recovery Team members. These devices allow staff to securely access NMDP information systems to complete identified critical tasks. Use of these devices protects personal identifying information of donors, patients, and registry members.

The annual operational impact analysis was conducted by each of 21 NMDP departments to validate and update critical tasks, assigned personnel, and required applications. A low-level evaluation of throughput necessitated increasing the number of critical staff to 175, a net change of over 30. The information system applications required for the critical tasks were tiered and provided to the IT Infrastructure Team for use in IT disaster recovery planning.

To sustain communications with Network partners during a severe operations disruption, the NMDP maintains a variety of redundant channels. The NMDP has over 150 active Governmental Emergency Telecommunications Service (GETS) emergency calling cards issued to RITN centers and NMDP staff and over 60 Iridium satellite telephones assigned and distributed to external partners. Recurring tests of each of these capabilities ensured user familiarity and equipment accountability.

Site visits to several NMDP operated donor centers resulted in improved preparedness for NMDP field staff. A review of the NMDP Operational Continuity Action Guide with each site manager and their staff ensured they know what to do for the major hazards applicable to their location. Processes for closing offices due to local hazards and transferring critical activity to other facilities was refined. Operated donor center site visits occurred in Oakland, CA; Rochester, PA; Spokane, WA; Richmond, VA; Portland, OR; and St. Petersburg, FL.

NMDP staff collaborated on a publication entitled “World marrow donor association crisis response, business continuity, and disaster recovery guidelines” (Biology of Blood and Marrow Transplant. 2012 Dec; 18(12):1785-9. doi: 10.1016/j.bbmt.2012.08.006. Epub 2012 Sep 8). The ability to safely and efficiently ensure continued operation of a donor registry relies on an

organization's resiliency in the face of an incident that could impede donor search, donor selection, stem cell collection, or transportation. The authors developed guidelines on how to establish an organizational resiliency program intended for donor registries initiating an emergency preparedness process. These guidelines cover the minimal requirements of preparedness in prevention and mitigation, crisis response, operational continuity, and disaster recovery, and the need for continued maintenance and revision.

II.B. Rapid Identification of Matched Donors – Hypothesis 1:

Increasing the resolution and quality of the HLA testing of volunteers on the registry will speed donor selection.

Continued advances in laboratory methods and supporting equipment have positively impacted the level of typing resolution and the number of loci tested for newly recruited volunteer donors.

- In December, 2011, five of six laboratories reported results at higher than intermediate level of resolution and one laboratory reported intermediate resolution.
  - Four laboratories reported three loci (HLA-A, B and DRB1)
  - Two laboratories reported five loci (HLA-A, B, C, DRB1 and DQB1) on 52% of all new donor samples.

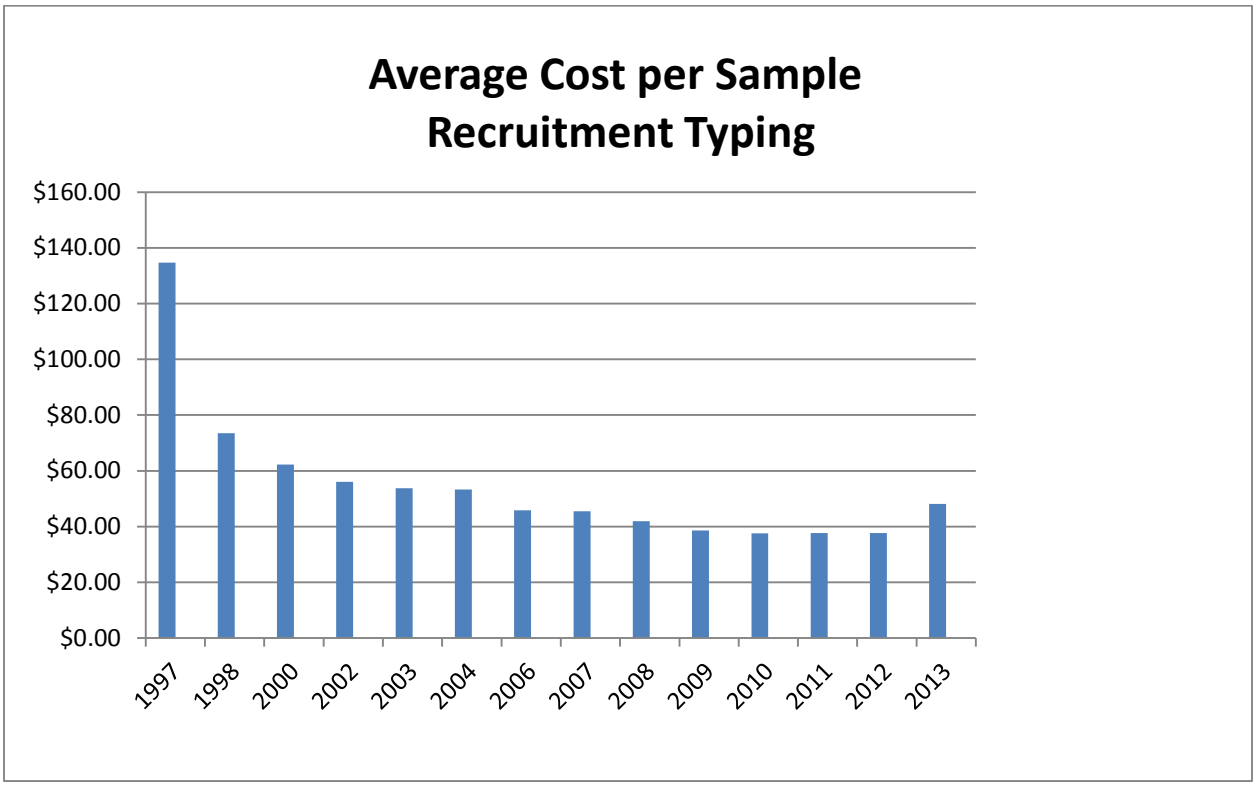
- In October, 2012, a sixth locus (HLA-DPB1) was added to 18% of new donor samples, and a seventh and eighth locus (HLA-DQA1 and DPA1) were added to 16% of new donor samples.

- In February, 2013, 100% of new donor samples received typing at five loci, 37% received typing at 6 loci, and 16% received 8 loci.

- The NMDP categorizes and sorts the incoming samples from newly recruited donors by sex and age in order to prioritize the young male and female donors (18-30 years of age) for the highest resolution typing performed using Sequence Based Typing (SBT) methods. In September, 2013, 100% of young male donor samples received six locus typing, and 100% of females received five locus typing, all via SBT.

- Over the past 15 years, the NMDP has successfully reduced the cost of HLA typing by over 60% while increasing the resolution and quality (Figure 10). The vision and efforts of the Navy to continually press the HLA community in this direction and to lead the advancement and development of new typing technologies has been instrumental in achieving gains in resolution and decreases in cost.

Figure 10. Per sample cost for new donor recruitment typing has decreased over 60% since 1997, while the level of resolution and the number of loci typed has continued to increase from low resolution HLA-A, B and DRB1 to high resolution HLA-A, B, C, DRB1, DQB1 and DPB1.



If a patient does not find a matched donor and is in urgent need, patient-focused drives can be held and the donor registration process can be expedited, shortening the length of time to listing from 6-8 weeks to 3 weeks. This process includes time to enter demographic data, confirm financial coverage, ship and receive the samples, and complete the HLA typing. Demographic data are entered within 72 hours for expedited samples and they are shipped the next scheduled day, Monday through Thursday. In case of a contingency event, high volumes of samples could be processed and shipped quickly using this established process.

The NMDP's exacting quality control processes have successfully increased the quality of typing received through the contract laboratory network. The inclusion of blind quality control samples in each laboratory's shipment of volunteer donor samples has provided more than 12 years of data for evaluation of the accuracy of high volume typing. Over this time, the accuracy rates have continued to improve, as documented by decreased monthly error rates and decreased discrepancies as donors are selected for patients and retyped by other laboratories. The effectiveness of this program and the efforts of a highly qualified high-volume HLA typing

laboratory network has resulted in a combined HLA class I and class II QC accuracy rate, from October 2011 to September 2013, of 99.9%.

Aim B.1.1: Increase Registry Diversity

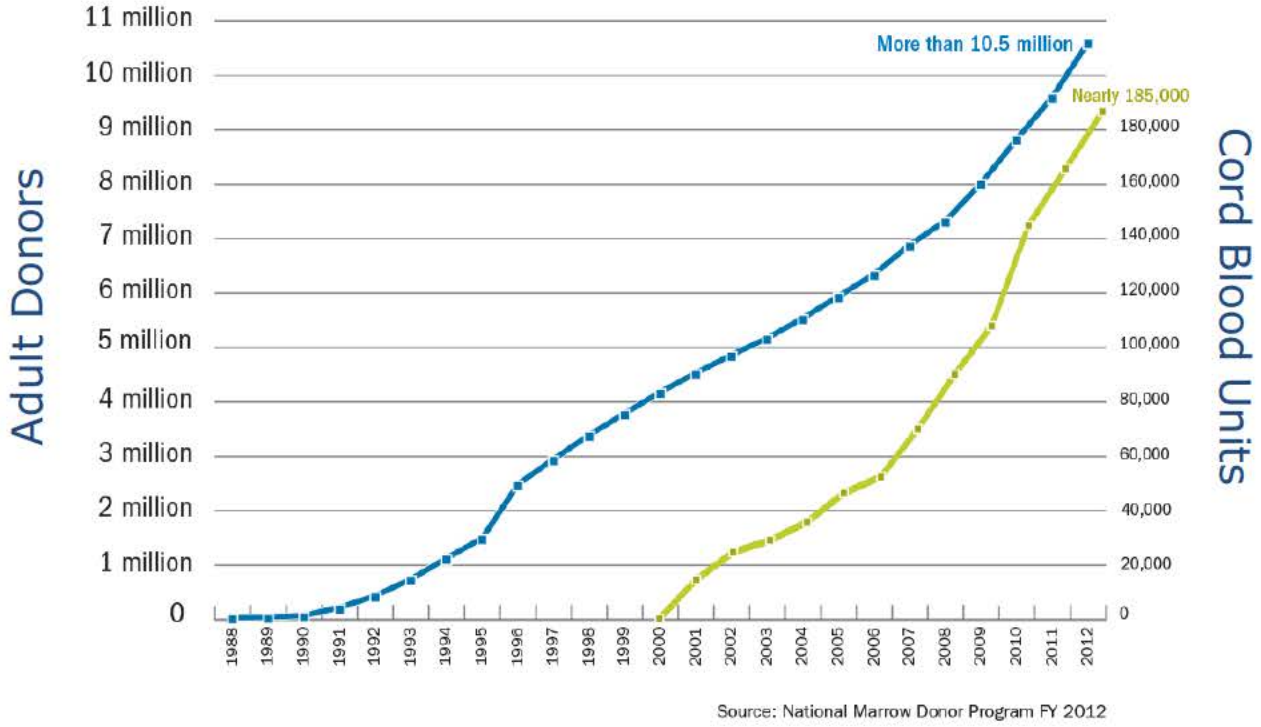
Expand the genetic diversity of the Registry through continued addition of adult donors and cord blood units, utilizing high volume HLA typing methodologies.

During NMDP's 2012 Fiscal Year (10/01/2011-09/30/2012), NMDP donor centers (including DoD) and recruitment groups recruited 240,657 minority race and 268,059 Caucasian donors, which were typed at minimum for HLA-A, B and DRB1. Navy funding contributed to the addition of 171,707 NMDP recruited donors (excluding DoD). This added a culturally diverse group of new donors to the Registry.

Advancing technology improved performance and pricing
Advances in laboratory methods and technology continue to have a positive impact on lab performance and pricing:

- Blinded quality control testing accuracy rate was 99.9%, exceeding the project requirement of ≤ 2.0% error rate.
- On-time testing completion rate was 98.6%, meeting the project requirement of a minimum of 90.0% of typing results reported within 14 days of shipment of samples.
- The cost of HLA typing continues to decrease as technology improves; as of September 2013 the average price per sample was approximately $49.50, compared to $134.75 in 1997, which represents a decrease of over 60%.

Figure 11. Total Growth of the Be The Match Registry: Adult Donors and Cord Blood Units



HLA Typing Laboratory Meetings

NMDP staff conducted site visits to each of the new member recruitment HLA typing laboratories to discuss topics including: the current scope of work, future goals for registry HLA typing, and the laboratory's future HLA testing vision. These discussions were important to allow the NMDP to continue to provide low cost and high quality HLA typing for patients searching the registry. In the longer term, laboratories are evaluating new and emerging technologies to decrease costs and increase resolution.

HLA Quality Testing

One HLA typing project was completed during this contract period. This study was designed to increase the resolution and quality of HLA typing on the registry to potentially speed donor selection and correctly characterize the match for searching patients, especially from diverse populations.

The NMDP maintains lists of rare alleles as a service to the American Society for Histocompatibility & Immunogenetics (ASHI). These lists are derived from HLA allele-level typings of patients, adult volunteers registered as donors, and cord blood units in the NMDP Registry. In previous typing projects it was found that rare alleles reported to the NMDP on adult volunteer samples were incorrectly reported due to various reasons including:

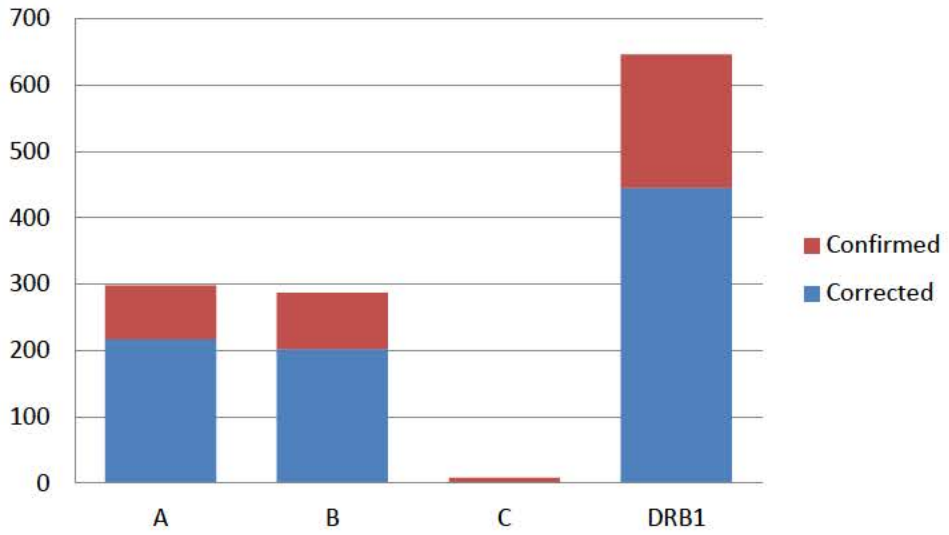
- Typing methodologies used to test the rare allele were problematic, resulting in a correction of some of the rare allele results
- Rare allele was typed more than 4 years ago and the allele has not been reported since
- Presence of two rare alleles in a donor typing
- Primary data interpretation didn't match the rare allele reported
- Rare allele was reported more than once on the same day with no haplotype to indicate the donors are possibly related

This project was expanded to evaluate uncommon alleles with occurrence of less than 1500 reported types in the Be The Match Registry. 73 unique alleles were evaluated and samples were identified as suspicious using the above criteria and retyped primarily by sequence specific oligionucleotide probes (SSOP) high definition technology to confirm the allele in question. A subset of alleles was typed using sequence based typing to ensure the accuracy of the SSOP technology. The results of this retyping project are summarized in Table 3 and Figure 12.

Table 3: Summary of the results of the uncommon/rare allele typing project

Locus	Corrected	% Corrected	Confirmed	% Confirmed
Total	864	70%	375	30%
A	217	73%	81	27%
B	202	70%	85	30%
C	-	-	8	100%
DRB1	445	69%	201	31%

Figure 12: Uncommon/rare alleles confirmed or updated on the NMDP Registry.



Results of these retyping projects improved the HLA typing accuracy and quality of listed adult volunteers. These projects highlight the importance of continuous monitoring of the Registry data and the necessity to upgrade typing routinely in order to provide the most accurate HLA data for searching patients.

Additional Presentations:
Beduhn E et al., *Deletion of unconfirmed rare alleles, C*03:12 and C*15:20,* Poster abstract presented at the 2012 American Society of Histocompatibility and Immunogenetics (ASHI) meeting. In brief, a prospective typing project to confirm HLA alleles with an unconfirmed status in the IMGT/HLA database identified sequence errors for 2 HLA-C alleles, C*03:12 and C*15:20. C*03:12 was described in November 1999 on a reference cell from a Be The Match Registry® volunteer. C*15:20 was described in February 2007 on a reference cell typed through an NMDP prospective high resolution typing project (Navy Grant 0859). As a result of the re-sequencing of the reference cells, which were found to contain errors, C*15:20 was deleted from the IMGT/HLA database in June 2012, and C*03:12 was deleted in January 2013. This project highlights the importance of confirming IMGT/HLA database allele sequences to validate existence of reported alleles.[1]

Kempenich JH et al., *HLA-A,B only typed donors: an untapped resource,* Poster abstract presented at the 2012 American Society of Histocompatibility and Immunogenetics (ASHI) meeting. In brief, race and ethnicity are a significant factor in the ability to find an unrelated stem cell donor match as a patient is most likely to find a match with somebody who shares his/her racial or ethnic heritage. A Caucasian patient will find at least a 7/8 donor on the registry 93% of the time, while only 66% to 73% of minority patients will find a 7/8 donor or better, depending on their race and ethnicity. Donors who are only typed at A and B are infrequently utilized by transplant centers. However, the minority AB only donor pool of 64,000 may carry unique phenotypes. These racial minority (non-Caucasian) donors were targeted for typing at HLA-DRB1 to identify what additional diversity may be present in the cohort and whether further typing could improve the search process for minority patients. In all race groups tested, over 25% of the donors carried an uncommon or unique phenotype contributing additional diversity to the ABDRB1 typed donor registry. Based on these results, additional typing of these donors can add additional diversity and should be considered.[2]

Aim B.1.2: Evaluate HLA-DRB1 High Res Typing

No funding was requested under this Aim for the 0142 budget cycle.

Aim B.1.3: Evaluate HLA-C Typing of Donors

No funding was requested under this Aim for the 0142 budget cycle.

Aim B.1.4: Evaluate Suitability of Buccal Swabs

Sample Storage Research Study

The 5-year Sample Storage Research Study began in September 2007, comparing frozen whole blood, blood spotted onto filter paper, and buccal swabs. Testing results through 5 years of real-time storage were summarized in the prior grant period. The results of the study will be presented in an oral abstract presentation at the November 2013 ASHI Annual Meeting entitled: "HLA typing of DNA from buccal swab and dried blood samples following prolonged storage at room temperature." Continuing evaluation of the results will continue to inform NMDP operational decisions on sample storage.

Frozen Buccal Swab Sample Storage Study

Storing buccal swab samples in a frozen state has been shown by others to preserve DNA integrity for longer periods than controlled room temperature storage. A new controlled storage study was initiated to determine the useful lifetime of frozen swabs for high resolution HLA typing. A limited feasibility study was completed in the current granting period and a long-term study was designed with timepoints extending to 40 years.

Frozen Buccal Swab Feasibility Study:

- Previously stored buccal swab samples were identified for 10 donors; one of the two remaining swabs was temporarily stored frozen at -30°C for one week (just the swab tip in a screw-cap vial). Both swabs (room temperature and frozen) for each donor were sent to the typing laboratory for evaluation of quality of DNA, quantity of DNA, and high resolution HLA characterization. Results indicate there were no differences in the laboratory's ability to correctly HLA type the temporarily frozen samples. There was also no observed degradation of the DNA quality or quantity when buccal swab samples were frozen. The lab did comment on the difficulty of using just the swab tips and their concern with contamination when handling samples.

- The study above was repeated with an additional 10 donors, freezing the intact full length swab in a plastic bag. Laboratory repeated testing and again found no differences in HLA typing or DNA quantity and quality with using plastic bags for storage of the frozen samples. Lab also commented that the handling of samples in the plastic bags is similar to the current processes and no concerns with contamination using this approach.

Frozen Buccal Swab Long Term Storage Study (timepoints from zero to 40 years):

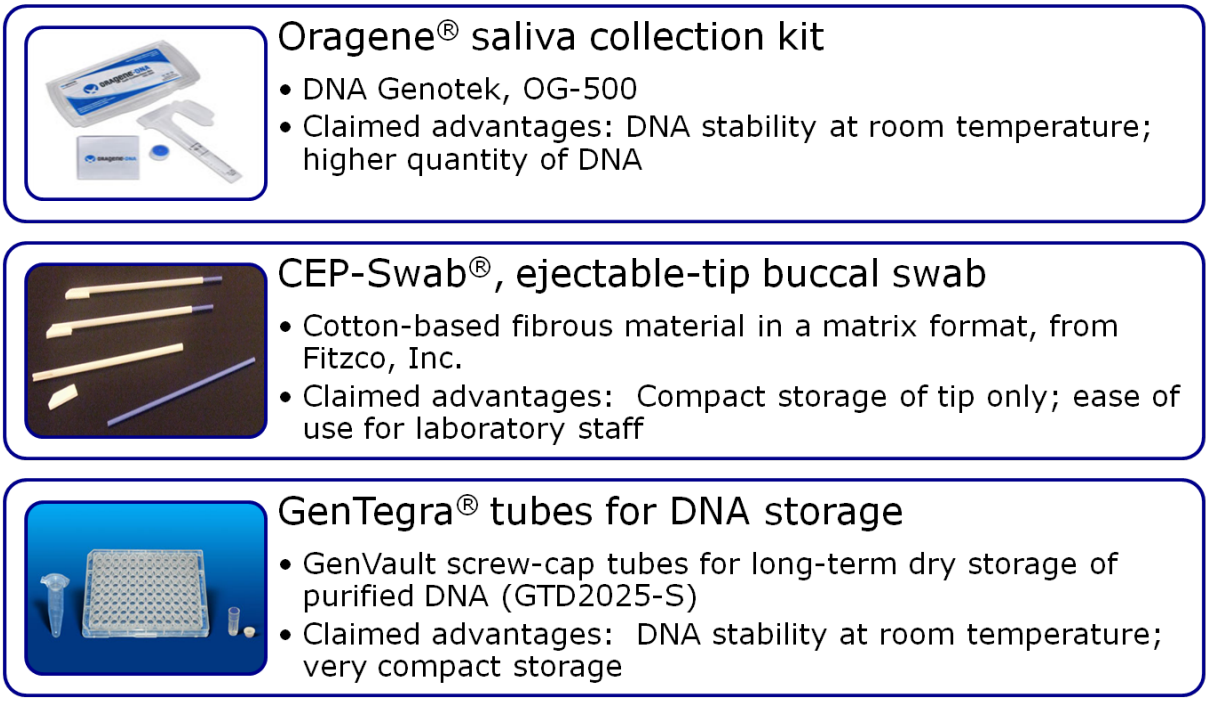
- For the baseline timepoint of a larger cohort of QC donors, that will compare swabs stored at room temperature and at -30°C, for quality of DNA, quantity of DNA, and high resolution HLA characterization, an NMDP IRB application for Bio-Medical Studies has been approved and the consent form is ready to begin enrolling volunteer QC donors and collecting their samples.

Alternate Sample Collection Methods Study

A limited feasibility study was conducted to evaluate alternate sample collection and storage methods, including possibilities for storage formats that offer increased sample lifetime, more compact storage, and greater downstream sample utility for further detailed typing. The potential to store DNA in a stable form at room temperature is an attractive possibility for the long-term storage of a resource that would be renewable and in an intact state for typing after decades of storage, when needed for patient or contingency needs. Sample sets were collected from 15 volunteer donors for evaluation. Each donor collected samples using:

- Oragene® DNA saliva sample collection kit from DNA Genotek
- CEP Swab®, an ejectable-tip buccal swab from Fitzco, Inc.
- Standard NMDP cotton-tipped buccal swab on polystyrene shaft

Figure 13: Summary of technologies for comparison to NMDP cotton-tipped buccal swab



In Stage 1, during a previous granting period, all collection methods were found to produce good quality DNA for HLA typing from fresh samples.

In Stage 2, the GenTegra dried DNA was amplified using Whole Genome Amplification (WGA) methods. A portion of the WGA DNA was stored frozen and a portion was again stored using the GenTegra dry DNA storage method.

In Stage 3, the final stage of the study, the samples generated in the first and second phases were sent for analysis to 2 laboratories. The analysis will continue into the next granting period, comparing the testing results from each original fresh sample (previously reported), with testing results from each stored sample (at 3 years of real-time storage), WGA-frozen DNA, and WGA-dried DNA.

Aim B.1.5: Enhancing HLA Data for Selected Donors

No funding was requested under this Aim for the 0142 budget cycle.

Aim B.1.6: Maintain a comprehensive quality control program

The NMDP's comprehensive quality control program has supported the successful increase in the quality of HLA typing received through the contract laboratory network. In addition, this program helps to ensure the accuracy of data obtained from research studies that support abstracts and publications. Blind Quality Control (QC) samples are added to each weekly shipment of new donor recruitment samples. These QC samples comprise 2.5% of each shipment, and must be indistinguishable from the donor samples. The Research Sample Repository contains frozen cells from thousands of fully HLA-characterized donors and recipients. QC swabs are created by the Repository staff from expanded B-LCL vials chosen from this resource. The immortalized B-Lymphocytic cell line (B-LCL) cells are applied to cotton-tipped swabs and included as QC in shipments of buccal swab donor samples.

One hundred and twenty-seven samples were requested from the NMDP Research Repository for the process of cell transformation, initiation, culture and expansion, for incorporation into the B-LCL QC HLA typing program. Of these, 74 (58%) exhibited negative cell growth. A total of 53 unique buccal B-LCL QC Masters were added to the inventory. As of September 30, 2013, 534 QC Masters were in active rotation. The highest volume recruitment laboratory is challenged with a unique QC Master every 7.5 weeks, 5.2 weeks at peak volume. These 53 samples help ensure that the NMDP QC inventory has near comprehensive coverage the CWD common US alleles, and expand alleles that were depleted to an n of 1 to maintain desired allelic diversity.

Alternative QC Sample Type: Purified Genomic DNA

A working group was established to formulate a pilot plan to supplement the blind QC program with a cost-effective alternative QC sample type that would increase the number of unique lots presented to laboratories, as well as increase the diversity of HLA types represented. B-LCL swabs are expensive and time consuming to prepare. Purified genomic DNA absorbed onto cotton-tipped swabs ("DNA-swabs") was investigated as an alternative, which has the potential to expand allelic coverage and diversity of HLA in the QC program by utilizing stored NMDP volunteer QC donor blood and Registry donors with desirable HLA types.

- Ten fully HLA-characterized NMDP volunteer QC donors were identified for inclusion in a pilot study to assess the feasibility of using purified DNA as an alternative QC sample type. DNA was extracted from stored frozen blood aliquots, and quantitative and qualitative analysis was performed. Frozen whole blood, swabs created from freshly extracted DNA, and real buccal swabs from the 10 volunteer NMDP QC donors were subsequently sent for testing to one lab. The swabs were HLA typed in an identical manner to the current HLA Typing of Registry Donors Agreement. In addition, the extracted DNA was evaluated for quantity and quality.
- Because the phase I of the pilot was considered a success, 8 purified DNA swabs and 8 real buccal swabs were subsequently shipped to all labs that routinely receive QC samples as a part of their work with either registry and/or customized typing agreements. In all, 5 labs, encompassing 4 customized and 3 recruitment agreements, participated in phase II of the pilot study. All but one customized lab was able to successfully type the purified DNA swabs in an identical manner to their negotiated HLA-typing agreements without issues, and no labs were able to detect a difference between the purified DNA vs. real buccal QC sample types. An additional set of purified DNA swabs was shipped to the lab that experienced problems with sample repeats. The lab was able to successfully type all 8 samples the second time.
- The pilot was considered a success and testing of the purified genomic DNA swabs will continue in a wider framework.

II.B. Rapid Identification of Matched Donors – Hypothesis 2:

Primary DNA typing data can be used within the registry to improve the quality and resolution of volunteer donor HLA assignments.

Aim B.2.1: Collection of Primary Data

In collaboration with the Bioinformatics Group at Anthony Nolan Trust in London, a new XML export of the IMGT/HLA database was developed. This new data combines the data included in the sequence alignments with the data available in the individual allele reports. This machine-readable format provides a standardised format for importing data from the reference database into local programs. The new XML format enables the identification of regions within the DNA sequence, such as specific exons and introns, as allows reconstruction of the sequence alignments. In addition the collaborative project has developed a suite of tools for importing the data into different database schema for allowing incorporation into different laboratory systems.[3,4] The XML format and associated tools are available from the hla.alleles.org website.

The XML export and tools were presented at ASHI, EFI, and WMDA meetings:

J Robinson, J Pollack, A Walts, J Schneider, R Fritsch, A Barber, J Freeman, M Maiers, SGE Marsh. AN XML EXPORT OF THE IMGT/HLA DATABASE. [3,4] (ASHI 2012 poster; EFI 2012 poster; WMDA fall 2012 poster).

A new database model for storing interpretation results was developed based on the new XML export of the IMGT/HLA database as reference for the Primary data interpretation process. The primary data interpretation algorithm was refactored for performance and optimized to the point where 10M results can be analyzed in 2 days.

Analysis of the requirements for including proprietary SBT reagents such as (such as HLA Ambiguity Resolution Primers (HARPs) from commercial SBT kit vendors) was completed and in collaboration with SBT analysis software vendors (e.g. GenDx, Connexio, SCORE) it was concluded that sequence-specific sequencing primers can be represented in the current HML message format by using the imputed sequence of the target allele the reagent is designed to bind to.

A manuscript is under preparation summarizing this system and its performance with the title "Impact of HLA Typing Laboratory Reporting Standards and Ambiguity Resolution Requirements on Registry Data Quality." The main section headings for the analysis are:

- Impact on Individual HLA Typings: Genotype List Format vs NMDP Allele Code Compression

- Impact on Haplotype Frequency Estimation: Genotype List Format vs NMDP Allele Code Compression
- Reinterpretation of typings to new HLADB version
- Validation of Reported HLA Typing versus DNA-Based Assays Performed
- Laboratory Ambiguity Reduction and Reporting Requirements

Aim B.2.2: Validation of Logic of Primary Data

No funding was requested under this Aim for the 0142 budget cycle.

Aim B.2.3: Reinterpretation of Primary Data

No funding was requested under this Aim for the 0142 budget cycle.

Aim B.2.4: Genotype Lists & Matching Algorithm

Health Level 7 (HL7) – HLA data reporting standards
NMDP Bioinformatics Research staff attended an HL7 meeting in Vancouver, British Columbia and participated in the Clinical Genomics Workgroup to develop constrained CDA for reporting HLA typing. In addition, an NMDP employee became a certified HL7 V3 RIM R1 Specialist.

Various options for the implementation of HL7 comliant HLA reporting methods, including CDA/GTR, hData, and FHIR were investigated, and further developed. hData is a non-HL7 specification for exchanging electronic health data, and FHIR is HL7's latest messaging standard development. Two abstracts on the development of HLA reporting standards were presented:

- Poster presented to The Joint 16th International HLA and Immunogenetics Conference/26th European Immunogenetics and Histocompatibility Conference/23rd British Society of Histocompatibility and Immunogenetics Conference) (June 1): "HL7 Implementation of Silver Standard Principles for Reporting HLA Typing"
- Oral abstract presented at ASHI 2012: "Tools for Implementation of Silver Standard Principles for HLA Typing".[5]

Genotype List (GL) String and GL Service

For the last 20 years, the histocompatibility and immunogenetics community has recorded HLA genotyping ambiguity using allele codes developed by the National Marrow Donor Program (NMDP). While these allele codes may have been effective for recording an HLA genotyping result when initially developed, their use today results in increased ambiguity in an HLA genotype, and they are no longer suitable in the era of rapid allele discovery and ultra-high allele polymorphism. To address this issue, the NMDP Bioinformatics Research team developed a text

string format capable of fully representing HLA genotyping results. This Genotype List (GL) String format is an extension of a proposed standard for reporting killer cell immunoglobulin-like receptor (KIR) genotype data that can be applied to any genetic data that uses a standard nomenclature for identifying variants. The GL String format uses a hierarchical set of operators to describe the relationships between alleles, lists of possible alleles, phased alleles, genotypes, lists of possible genotypes, and multilocus unphased genotypes, without losing typing information or increasing typing ambiguity. When used in concert with appropriate tools to create, exchange, and parse these strings, we anticipate that GL Strings will replace NMDP allele codes for reporting HLA genotypes. The GL String manuscript was published in Tissue Antigens.[6]

The GL service is a RESTful web service for representing allelic and genotypic ambiguity in human leukocyte antigen (HLA) and related nomenclatures. The source code repository, binary downloads, and developer documentation are available at http://genotype-list.googlecode.com. An instance of the genotype list service without restriction to nomenclature is available at http://gl.immunogenomics.org/1.0, and an instance of the genotype list service populated with the latest IMGT/HLA nomenclature is available at: http://gl.immunogenomics.org/imgt-hla/3.10.0.

The GL service was presented at the 2013 EFI meetings and accepted for presentation at the 2013 ASHI Meeting:

Robert P. Milius, Michael Heuer, Joel Schneider, Mike George, Pradeep Bashyal, Doug Schneyman, Jane Pollack, Steven J. Mack, Jill A. Hollenbach, Martin Maiers. The GL service: web service to exchange GL string encoded HLA genotypes with complete and accurate allele and genotype ambiguity. Tissue Antigens 2013; 81(s1): Abstract P-155.

A manuscript describing the GL Service is in preparation.

Traxis

The NMDP search report software, Traxis, was modified to take advantage of Silver Standard principles. In the first iteration allele codes in match results were removed and replaced with the most likely genotype for each locus. A tooltip feature was added that displays the full list of possible genotypes ranked by probabilities when the user hovers the cursor over the displayed results. For printable reports, QR codes were added for each potential donor on a PDF search report which links to full results for each donor. This allows users to access to search results metadata around each potential donor. A Web Service interface to the HapLogic search server that computes match grades and predictions for all loci was created.

II.B. Rapid Identification of Matched Donors – Hypothesis 3:

Registry data on HLA allele and haplotype frequencies and on the nuances of HLA typing can be used to design computer algorithms to predict the best matched donor.

Aim B.3.1: Phase I of Expectation Maximization (EM) Haplotype Logic

Quarterly Updates of Haplotype Frequencies
A project to automate quarterly haplotype frequency updates to HapLogic was initiated, which included reinterpretation of HLA primary typing data to the latest allele list, regeneration of haplotype frequencies and updates to the HapLogic III frequencies. The Expectation Maximization algorithm implementation has been improved with major components migrated from perl to java resulting in a 100-fold speed improvement. Work continues on the downstream integration and automation of these frequency updates including a framework to validate and measure the improvement in matching prediction accuracy with each update.

Non-Inherited Maternal Alleles (NIMA) Matching
Patients receiving a cord blood transplant sometimes cannot find a 6/6 allele match on the critical HLA-A, HLA-B, and HLA-DRB1 genes, and have to settle for a 5/6 or 4/6 allele match. Retrospective studies have shown improved mortality rates and improved overall survival rates among patients matching at 5/6, where the mismatched allele matches one of the Non-Inherited Maternal Alleles (NIMA). Currently, when a patient searches the Be the Match registry for potential donor, NIMA matches are not reported to the patient. In preparation for this type of matching cord inventories were modeled using random sampling. This allowed examination of the questions of whether including NIMA information would be beneficial to transplant centers and therefore patients, which mothers to type and when, as well as how to recruit cord blood units.

The data show a substantial increase in match rates for all the race groups in Be the Match Registry if NIMA is considered. For patients of European origin (NAMER), 24% of patients were able to find a 5/6N+ (NIMA) match. An additional 13% of patients were able to find a 4/6++ (double NIMA) match. This proportion is higher in minorities since the baseline match rates are lower. The analysis suggested that if maternal HLA was available match rates would increase by roughly 40% across all race groups (Figure 14).

Figure 14: Average cumulative match rate without regard to cell dose. This reflects the Be the Match inventory as of January 1, 2012. Segments representing the proportion of patients finding a particular match rate are arranged from 6/6 to 4/6 rate. The orange segments are the proportion of patients expected to be able to "upgrade" from a 5/6 to a 5/6+ (NIMA) match. The dark-green segments are the proportion of patients expected to be able to upgrade from a 4/6 to a 4/6++ (double NIMA) match.

Race	Inventory	6/6	5/6n	4/6nn	5/6	4/6n	4/6	stackchart
AAFA	10907	0.08974	0.2374	0.3854	0.7506	0.9311	0.998	
AFB	621	0.08232	0.2176	0.3601	0.7211	0.926	0.9988	
AINDI	4998	0.1663	0.3891	0.5759	0.8489	0.9729	0.9991	
AISC	16	0.3451	0.5619	0.72	0.9123	0.9836	0.9996	
ALANAM	4	0.2568	0.4688	0.6198	0.8763	0.9695	0.9995	
AMIND	117	0.3221	0.5513	0.7204	0.9181	0.9822	0.9994	
CARB	748	0.08674	0.2226	0.3607	0.7461	0.9261	0.9975	
CARHIS	6932	0.1988	0.3779	0.5361	0.8385	0.9624	0.9994	
CARIBI	14	0.1873	0.3546	0.5132	0.8123	0.9533	0.9983	
FILII	1356	0.254	0.4803	0.633	0.8923	0.9631	0.9988	
HAWI	284	0.1392	0.2956	0.438	0.7663	0.9124	0.9957	
JAPI	717	0.1976	0.3926	0.5629	0.8554	0.9561	0.9983	
KORI	2300	0.2149	0.4051	0.5672	0.8713	0.9638	0.9985	
MENAFC	4820	0.2443	0.468	0.6315	0.8761	0.9735	0.9988	
MSWHIS	17924	0.2727	0.4838	0.6391	0.8908	0.9723	0.9998	
NAMER	85096	0.4871	0.72	0.8484	0.9568	0.9928	1	
NCHI	2563	0.2245	0.4343	0.5972	0.8872	0.9681	0.9997	
SCAHIS	8241	0.2317	0.4283	0.5964	0.8628	0.9685	0.9997	
SCAMB	131	0.1051	0.2488	0.381	0.7227	0.9055	0.9942	
SCSEAI	686	0.1537	0.3455	0.5163	0.8493	0.9625	0.9994	
VIET	649	0.2367	0.4217	0.5719	0.8591	0.9534	0.9991	

Aim B.3.2 Enhancement of EM Algorithm

A manuscript describing 6-locus haplotype frequency data utilized in HapLogic III was prepared and published:

Gragert L, Madbouly A, Freeman J, Maiers M. Six-locus high resolution HLA haplotype frequencies derived from mixed-resolution DNA typing for the entire US donor registry. Hum Immunol. 2013 Oct;74(10):1313-20. doi: 10.1016/j.humimm.2013.06.025. Epub 2013 Jun 24.

The Registry Diversity component of International Histocompatibility and Immunogenetics Workshop (IHIW) was initiated. The goal of this project was to validate bioinformatics methods and tools for HLA haplotype frequency analysis specifically addressing unique issues of haematopoietic stem cell registry data sets. In addition to generating new methods and tools for the analysis of registry data sets, the intent is to produce a comprehensive analysis of HLA data from 20 million donors from the Bone Marrow Donors Worldwide (BMDW) database. A report summarizing the activity on this project was published:

16(th) IHIW: global analysis of registry HLA haplotypes from 20 million individuals: report from the IHIW Registry Diversity Group. Maiers M, Gragert L, Madbouly A, Steiner D, Marsh SG, Gourraud PA, Oudshoorn M, van der Zanden H, Schmidt AH, Pingel J, Hofmann J, Müller C, Eberhard HP. Int J Immunogenet. 2013 Feb;40(1):66-71. doi: 10.1111/iji.12031.

Four posters were presented at the 38th Annual ASHI meeting in San Juan, Puerto Rico:.

1. Gragert L, Maiers M, Smith S, et al. HLA haplotype frequencies and match rates for the Canadian Onematch Registry. Human Immunol 2012; 73(s): 93-P.
2. Al-Awwami M, Al-Jurf M, Al-Humidan H, et al. HLA haplotype frequencies in Saudi Arabia for design of a Saudi stem-cell registry. Human Immunol 2012; 73(s): 85-P.
3. Maiers M, Freeman J, Howard A, Chen DF. Prediction of HLA antigen matching probabilities for patients being considered for solid organ transplants. Human Immunol 2012; 73(s): 35-P.
4. Robinson J, Pollack J, Walts A, et al. An XML export of the IMGT/HLA database. Human Immunol 2012; 73(s): Abstract 189-P.

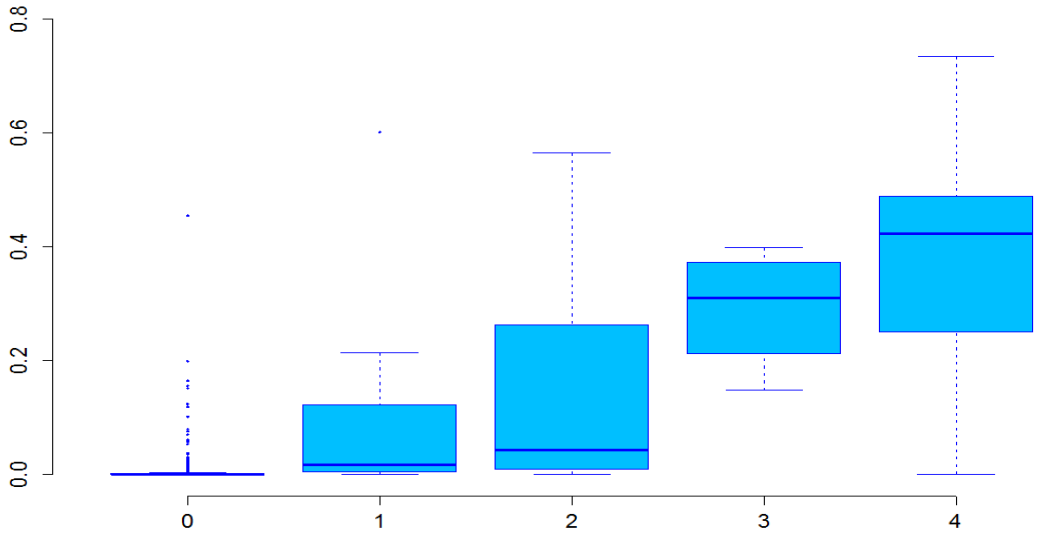
One oral presentation was given at the 38th Annual ASHI meeting.

1. Milius B, Schneider J, Heuer M, et al. Tools for implementation of silver standard principles for HLA typing. Human Immunol 2012; 73(s): Abstract 8-OR.

Aim B.3.3 Optimal Registry Size Analysis

A pilot study that evaluated a novel self-identified race and ethnicity (SIRE) questionnaire in a sample of individuals from within the registry was initiated. The study design was presented at the annual NMDP Council meeting in November 2012. The Ancestry Questionnaire Pilot (AQP) project completed its enrollment and preliminary analyses of the questionnaire data and HLA were initiated. An interesting preliminary finding is that asking about grandparents can also help potentially refine the term “Hispanic.” In Figure 15 below, the proportion of Native American genetic ancestry a respondent has (using ancestry informative genetic markers) is plotted against the number of Latin American grandparents.

Figure 15. Plot of Native American genetic ancestry and number of Latin American grandparents for questionnaire respondents.



An analysis of DPA1~DPB1 haplotypes was published:

"A combined DPA1~DPB1 amino acid epitope is the primary unit of selection on the HLA-DP heterodimer." Hollenbach JA, Madbouly A, Gragert L, Vierra-Green C, Flesch S, Spellman S, Begovich A, Noreen H, Trachtenberg E, Williams T, Yu N, Shaw B, Fleischhauer K, Fernandez-Vina M, Maiers M. Immunogenetics. 2012 Aug;64(8):559-69. doi: 10.1007/s00251-012-0615-3. Epub 2012 Apr 13.

This study was further expanded to include data from other populations, as well as phylogenetic analysis of these genes. These results were presented in a plenary talk at the European Federation for Immunogenetics meeting in Maastricht in May 2013.

Aim B.3.4: Target Under-Represented Phenotypes

Several approaches were pursued to develop new methodologies to target underrepresented HLA phenotypes to increase the diversity of the registry. A meeting with John Novembre (Assistant Professor, Department of Ecology and Evolutionary Biology) was held at the University of California-Los Angeles to discuss approaches for modeling HLA geographical concordance.

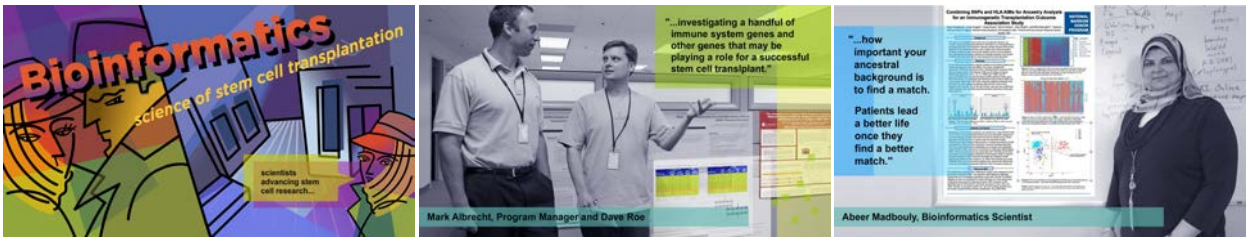
A Pedigree tool (http://pedigree.haplostats.org/Pedigree/home) was developed to identify haplotypes by comparing the HLA typings of related individuals. A new capability of "Allele Inference" was added which can fill in un-typed alleles and produce higher resolution typing of typed alleles based on shared haplotypes. Also added to the tool was code that permits an

arbitrary number of related individuals. There is now no limit to the family size, but families larger than 200 greatly slow the algorithm. A poster on pedigree analysis was presented at EFI, 2012.

Aim B.3.5: Bioinformatics Web Site

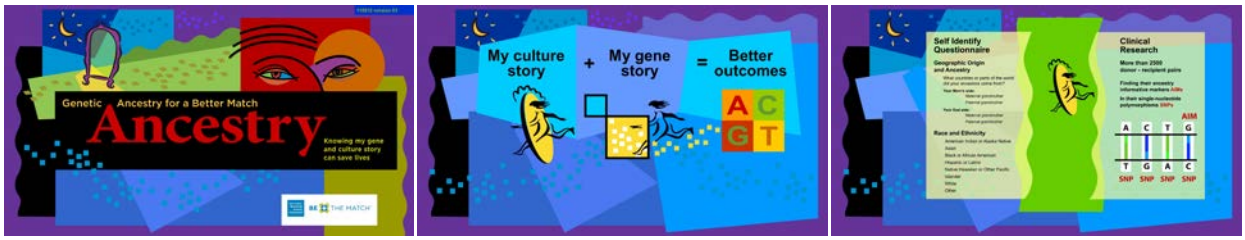
A video about bioinformatics was produced for the web site which included script, storyboard, illustrations, photography, interviews and sound editing. This was entitled “Bioinformatics: who are they, what do they do". This was posted on bioinformatics.nmdp.org (Figure 16):

Figure 16. Bioinformatics video screen shots



Another video, "Genetic Ancestry for a Better Match", was produced and shown at the 2012 Council meeting (Figure 17):

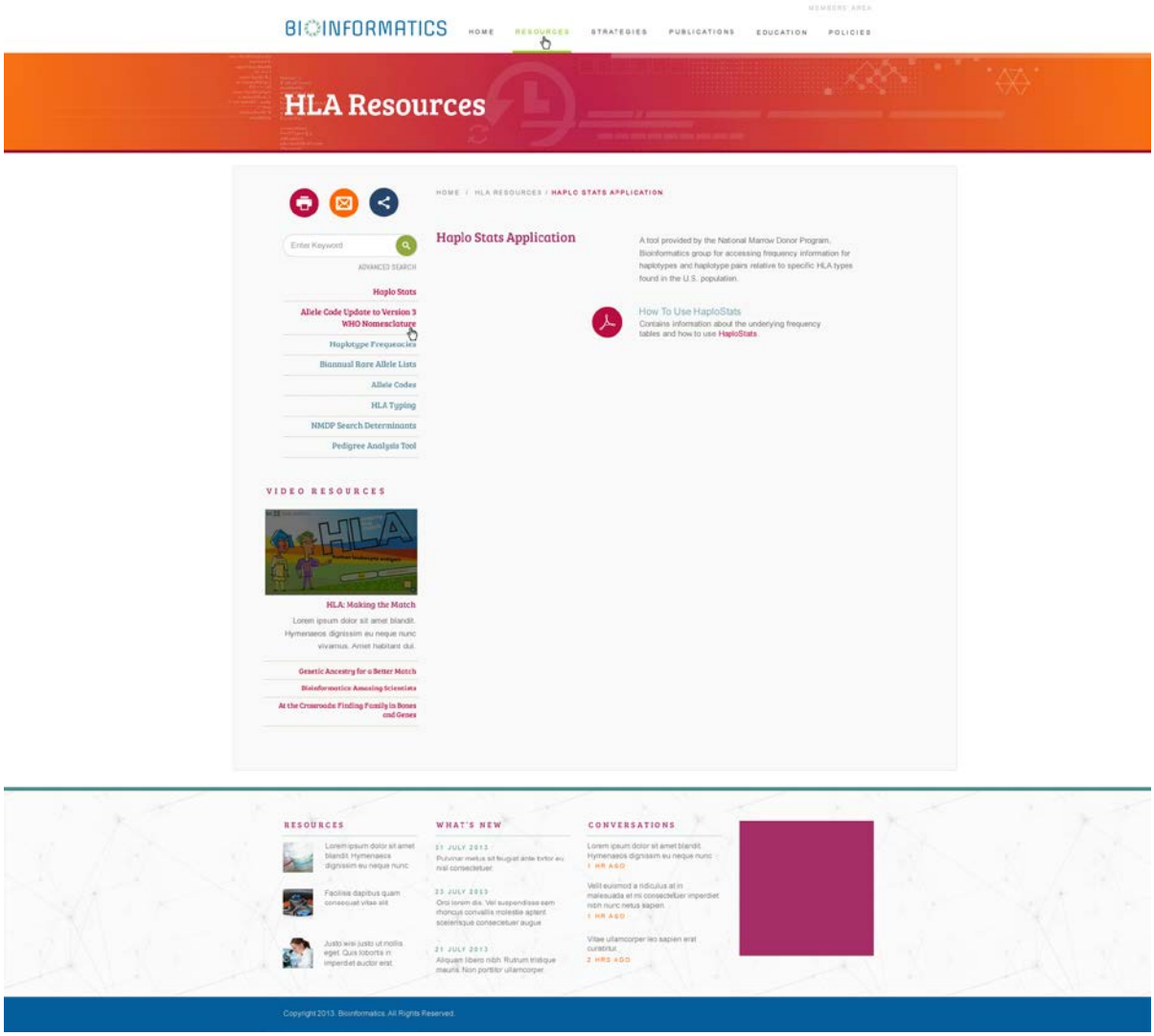
Figure 17. Bioinformatics video screen shots



Research to develop content for "What is HLA" video was carried out, and a storyboard was created for this video.

Preliminary design work was carried out for the new Bioinformatics website (Figure 18). In addition, the initial design and prototype work on user permissions database to support single sign-on capability was carried out, to allow access to Bioinformatics web tools.

Figure 18. Screenshot of new Bioinformatics website.



Aim B.3.6: Maximize the ability of the software to identify the best donors/cords for each patient

Search Archive

HapLogic performs well at providing the likelihood of an HLA match. For HapLogic to progress to a full fledged "donor selection" algorithm, we need to capture data to understand how donor selection decisions are made. Currently, the NMDP does not store search results. Analyses of selection practices are not possible beyond the short-term storage of the most recent

search results. The context of request activity and the attributes of the products at the time of requests are lost.

The development of a search archive will allow the future development of tools and analyses to be able to look at matching, sorting and donor selection in a systematic way and improve it.

During the grant period, work was initiated to store match results and all actions related to generating a search listing for incorporation into a search archive. Recording the full state of the search report at the time of the first patient directed request would allow us to determine if the selected donors were at the top of the sort and attempt to determine why other highly-ranked donors were not selected.

II.B. Rapid Identification of Matched Donors – Hypothesis 4:

Reducing the time and effort required to identify closely matched donors for patients in urgent need of HSC transplants will improve access to transplantation and patient survival in the context of a contingency response and routine patient care.

Aim B.4.1: Expand Network Communications

No activity was proposed for this Aim under the current grant.

Aim B.4.2: Central Contingency Management

African American Few 10/10 Matched Donor Study
African American (AFA) patients represent an underserved population of patients seeking an unrelated stem cell transplant in the NMDP Registry. Increased HLA diversity, relatively low AFA donor representation on the registry, compounded with low AFA donor availability results in challenging searches for AFA patients. A study was initiated to evaluate NMDP process interventions for AFA searches, which included proactive HLA expert review of AFA patient searches, proactive donor contact to confirm interest and availability, and proactive donor HLA typing upgrades. This study aimed to examine whether clearly identifying matches for TCs with AFA patients can decrease the time and increase the likelihood of AFA patients making it to search formalization and transplant. This randomized group of AFA patient searches was compared to AFA patients who followed the typical path through the NMDP where pre-search donor contact occurs under a computer selection algorithm, and search strategy advice and donor HLA typing are performed upon TC request.

Patients were randomly enrolled into one of two arms; 182 had intervention activities performed on the search, while 178 had no intervention. For the 182 patients in the intervention arm, 2473 donors were selected for pre-emptive contact and 591 available donors were HLA typed. Ultimately 217 matched and available donors were sent to transplant centers on behalf of 115 patients.

The searches are currently maturing and will be analyzed at 3 months, 6 months, and 12 months timepoints post project to determine if preemptive contact and typing has increased the speed and number of AFA patients making it to formalization and transplant. This project will be instrumental in understanding the ability for NMDP process changes to increase AFA patients getting to transplant, particularly in time of a contingency event. This will also help inform a model of potential impact to other non-caucasian patient groups who also have lower likelihood of achieving unrelated HCT.

Additional Presentations:

John Hermanson et al: "Young male donors provide the best chance of meeting requested cell dose for PBSC and bone marrow transplantation," oral abstract presented at the 2013 BMT Tandem Meeting. In brief, this study showed that younger donor age resulted in an increased likelihood of meeting the transplant physician's requested TNC or CD34+ dose. Lower donor age also was associated with inceased CD34+ cell dose from PBSC collections, but not the TNC/kg obtained from marrow collections. In addition, male donors provided increased CD34+ cells/kg donor weight than female donors. Transplant center practice is often to select young male donors for patients, and this data provides evidence to support that such practice may increase the likelihood of a providing a product meeting a center's request.[7]

Jason Dehn et al: "How Much is Enough? Ethical Consideration for the Depletion of Large Public Cord Blood Units," poster abstract was presented at the 2013 BMT Tandem Meeting. In brief, this study showed that CBU used in transplant for children can exceed 20 x 10^7 TNC/kg. These CBUs have a large TNC and could be suitable for adolescent or adult single cord transplantation. Although 74 CBU transplants correspond to a small proportion of total pediatric (age 12 and under) single CBU transplant during this timeframe (n=951), these units may offer the only opportunity for an adult patient. With a limited number of CBUs achieving high TNC available for adult patients, consideration of the ethics of providing a young patient with an adequate TNC CBU (e.g. 10-20 x 10^7 TNC/kg) vs the largest TNC CBU will continue to confront the community.[8]

Rapid identification of potential donors for newly diagnosed AML patients
The Southwest Oncology Group (SWOG) has identified the time from diagnosis of AML to transplant as critical for successful treatment of patients with cytogenetically defined high risk disease. Proceeding to transplant within four months of diagnosis for patients with high risk disease in first chronic remission could potentially improve the overall disease free survival rates. Currently, these patients are referred for transplant following cytogenetic screening and several lines of therapy. The initial diagnosis and treatment phase can take several months significantly delaying the initiation of an unrelated donor search and making transplant within four months highly unlikely. NMDP/CIBMTR up front involvement would permit the rapid identification and pre-search screening of potential donors, so patients will be well along in the search process when/if ultimately referred for HCT.

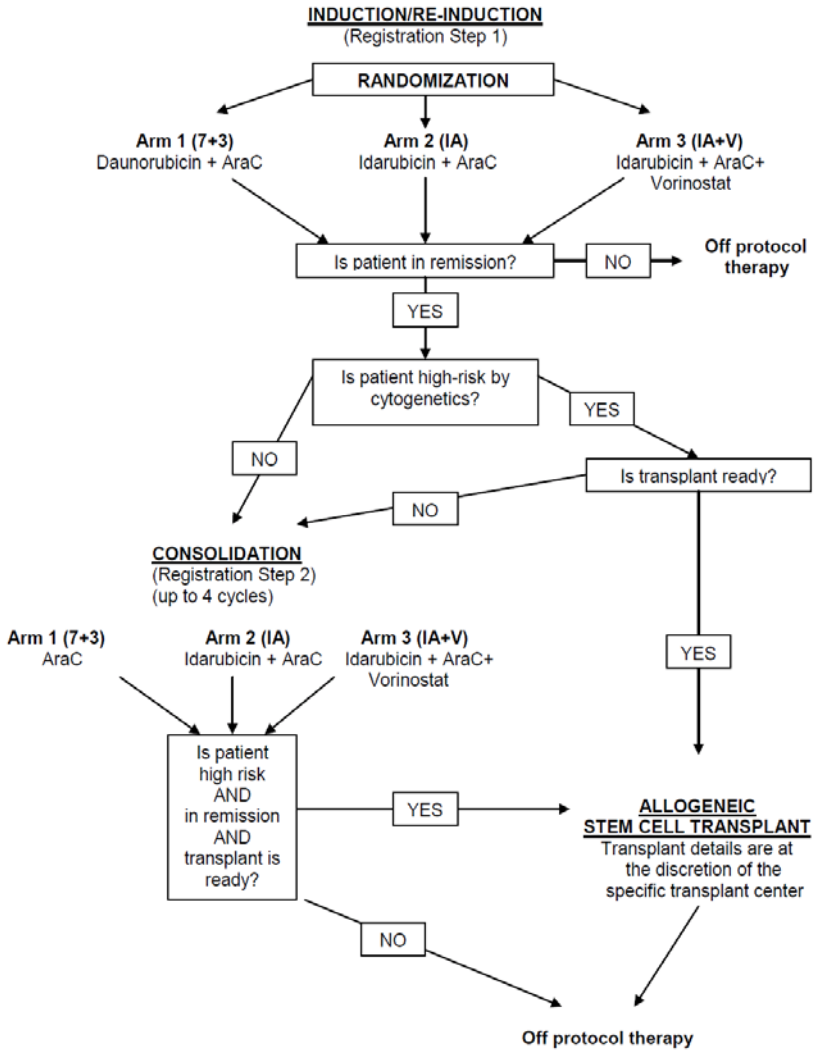
In April 2013 SWOG initiated the clinical trial entitled, "S1203: A Randomized Phase III Study of Standard Cytarabine plus Daunorubicin (7+3) Therapy or Idarubicin with High Dose Cytarabine (IA) versus IA with Vorinostat (IA+V) in Younger Patients with Previously Untreated Acute Myeloid Leukemia (AML)". The trial is a randomized phase III trial of cytarabine and daunorubicin hydrochloride or idarubicin and cytarabine with or without vorinostat to see how well they work in treating younger patients (18-60 years old) with previously untreated acute myeloid leukemia. Drugs used in chemotherapy, such as cytarabine,

daunorubicin hydrochloride, idarubicin, and vorinostat, work in different ways to stop the growth of cancer cells, either by killing the cells or stopping them from dividing. Giving more than one drug (combination chemotherapy) and giving the drugs in different doses and in different combinations may kill more cancer cells. It is not yet known which combination chemotherapy is more effective in treating acute myeloid leukemia. The study includes a transplant arm for patients diagnosed with high risk cytogenetics following the initiation of induction therapy (see Figure 10 below). NMDP/CIBMTR is supporting the project using grant funds to provide study-specific sample collection kits for all enrolled patients, processing samples, HLA typing patients that are diagnosed as cytogenetic high-risk and generating preliminary search strategy reports to assist in the identification of donors and/or CBUs through the NMDP. The resulting search information is provided to the S1203 transplant arm principal investigator who shares the data with the referring physician. The study opened in April 2013.

April 2013 – September 2013 activity:

- 80 patients enrolled in the study.
- 79 kits have been sent to patients
- 65 kits were collected and returned to the repository
- 17 patients are considered high-risk or unknown risk
- 17 patients have been HLA typed
- 17 patients have had a preliminary search completed

Figure 19. S1203 trial randomization and treatment schema.



Aim B.4.3 Conduct a transplant center benchmarking analysis to identify center-specific factors (e.g., quality management techniques and processes) that contribute meaningfully to superior survival outcomes. Share processes that contribute to superior outcomes with the entire TC network as best practices.

No funding was requested under this Aim for the 0142 budget cycle.

Aim B.4.4 Identify plans to expand capabilities of collection center and apheresis center network to meet increasing number of donor product requests on both a short-term and long-term basis.

No funding was requested under this Aim for the 0142 budget cycle.

II.C. Immunogenetic Studies – Hypothesis 1:

HLA mismatches may differ in their impact on transplant outcome, therefore, it is important to identify and quantify the influence of specific HLA mismatches. In contingency situations it will not be possible to delay transplant until a perfectly matched donor can be found.

Aim C.1.1: Donor Recipient Pair Project

HLA mismatches may differ in their impact on transplant outcome, therefore, it is important to identify and quantify the influence of specific HLA mismatches. In contingency situations it will not be possible to delay transplant until a perfectly matched donor can be found.

Donor Recipient Pair Project

In 1994 a retrospective donor/recipient pair HLA typing project to characterize class I (HLA-A, B, C) and class II alleles of donor/recipient paired samples from NMDP's Repository was initiated. The goals of this ongoing research project are to assess the impact of DNA-based HLA matching on unrelated donor transplant outcome, develop strategies for optimal HLA matching, and evaluate the impact of matching at alternative HLA loci on transplant outcome and to promote the development of DNA-based high resolution HLA typing methodologies. The project has also incorporated presence/absence typing of 14 KIR loci (2DL1-5, 2DS1-5, 3DL1-3 and 3DS1) for the past several years.

- 345 donor/recipient paired HLA and KIR typing results were audited during this period.
- Typing was completed on 297 unrelated donor/recipient pairs. The data audit was initiated and will be completed in the next grant period.
- Typing was completed on 168 single cord blood transplants and 33 double cord blood transplants. This was the first set of double cord transplants typed through the project.
- To date over 14,500 pairs have been high resolution typed and over 6000 samples have been typed for presence/absence of 14 KIR loci (2DL1-5, 2DS1-5, 3DL1-3 and 3DS1).

Antigen Recognition Domain Allo-Reactivity Assessment Project

Amino acid mismatches outside the antigen recognition domain (ARD) (i.e., exons 2 and 3 for HLA class I and exon 2 for class II) are ignored under current HLA matching guidelines with the assumption that these differences are irrelevant. There is little data to confirm or refute this assumption; furthermore, the amount of data needed to form a conclusion is unattainable.[28] In order to provide more information, the ARD allo-reactivity assessment project will provide insight into the allowable percent tolerance of matching needed outside of the ARS. It is collaboration between the NMDP and Europdonor under the direction of Machteld Oudshoorn and Franz Claas from Leiden, The Netherlands.

To date analysis on six combinations of four haplotypes with mismatches of DRB1*14:01 and DRB1*14:54 and DRB3*02:01 and 02:02 respectively has been initiated. Preliminary results demonstrated two weakly positive and one positive result. Interestingly all positive results occurred in one direction only, which is DRB1*14:01 / DRB3*02:01 against DRB1*14:54 / DRB3*02:02. Analysis of the class I ARS mismatches was performed. Haplotypes including A*02:01 and 02:09, B*44:02 and 44:27, C*07:01, 07:06 and 07:18 were analyzed and it was determined that the selected pairs did not travel on the same haplotypes.

During the grant period, data from the class II analysis was presented in an oral abstract[29] at the 2013 EFI conference in Maastricht, The Netherlands, while the class I analysis will be presented at ASHI 2013 in Chicago and will be written up for publication shortly after. Further analysis of the DRB1*14:01 and DRB1*14:54 results will be performed. Further testing on donor samples containing the haplotype pairs of interest will be collected and tested.

II.C. Immunogenetic Studies – Hypothesis 2:

Even when patient and donor are HLA matched, GVHD occurs so other loci may play a role.

Aim C.2.1: Analysis of non-HLA loci

Recent research has heightened interest in additional genetic polymorphisms which may modify the outcomes of transplantation. HLA genes, other than the major histocompatibility complex (MHC) found on chromosome 6, and non-HLA genetic factors may all influence the suitability and success of allogeneic stem cell transplants. The largest body of data with clear correlation to unrelated stem cell transplant outcome was surrounding the role of Natural Killer (NK) cells. These cells express inhibitory receptors (KIR) that specifically interact with MHC class I molecules. Genes encoding for these Ig-like ligands are found on chromosome 19. The regulatory mechanism mediated by these receptors is thought to protect normal cells from autologous NK attack, while rendering cells for which class I expression is compromised (e.g. by tumor transformation or viral infection) or incompatible (e.g. by stem cell transplant) susceptible to NK-mediated killing. This has been shown to be responsible for anti-leukemic effects and protection against GVHD following allogeneic HSC transplantation.

Based on this information, the NMDP developed a pilot study to perform KIR typing utilizing selected donor and recipient pair samples. The project was launched in early 2005 with ongoing support provided through the project period. The NMDP selected three laboratories to participate in the project through a competitive bid process. The primary objectives of the study were to:

- Move technology forward from the current practice of locus level typing to high resolution typing
- Disseminate information and protocols in an open source mechanism
- Develop reference lines for use in individual laboratories. Additionally, the project will provide more fully characterized and high quality controlled transplant pairs for use in research studies connecting these factors to clinical outcome data.

A manuscript describing the results of the high resolution KIR typing project data was accepted for publication in PLoS One:

Vierra-Green C, Roe D, Hou L, et al. Allele-level haplotype frequencies and pair wise linkage disequilibrium for 14 KIR loci in 506 European-American. PLoS One. 2012;7(11):e47491. doi: 10.1371/journal.pone.0047491. Epub 2012 Nov 5.

Genetic Ancestry Outcomes Study

A study protocol was submitted to the CIBMTR Immunobiology Working Committee to study the effect of matched genetic ancestry of donors and patients on transplant outcomes. A pilot group of 376 samples were genotyped using an AIMs panel, including custom assay design, oligo acquisition, assay validation.

The Immunobiology Project Results (IPR) database

The Immunobiology Project Results (IPR) database and its applications allow for storage and analysis of immunogenetic data collected on NMDP research samples. This database has replaced the existing HLA donor/recipient pair's database and facilitates storage and analysis of data from other immunogenetic loci.

A new release of the Immunobiology Project Results (IPR) application was promoted to the production environment to support the retrospective donor/recipient pairs HLA and KIR typing projects. Features included:

- The migration of historical data from the legacy system.
- A 'Completed Pairs' report that summarizes the extent to which each sample group is complete.
- An enhanced 'Study Sideways' report which displays the audit and active status of each transplant pair along with the final typings to be used in studies.
- A report to assist the audit process by reporting on unexpected/unusual B-C linkages.

Audit rules for KIR data were created and a plan was developed to resolve samples that are inconsistent with those rules.

- Storage and display options of the pseudo genes, 2DP1 and 3DP1 were included.
- Further refinement of the Audit Tool and Audit Report occurred.
- Full support was added for multiple-donor/cord blood transplants.

Also, development continued on the next release. Planned changes include:

- Post-project B/C linkage audit report
- Post-project DRB linkage audit report
- New functionality for exporting IPR reports to Excel and other formats.

Immunobiology Integration DataBase (IIDB)

Activity on the Immunobiology Integration DataBase (which is a combined repository for infusion outcomes data for research purposes) project:

- Updated validation code to handle allele lists for a locus typing, and to correctly interpret common abbreviations and alternate formats.

- Rigorous quality assurance tests were developed.
- Updated match grade calculation to handle allele lists for a locus typing.
- The validation and match grade calculations are now run daily.
- Implemented HapLogic Service interface to link HapLogic matching results to all historical transplant pairs. This code has been run on 96,000 historical records.
- Added a structure for ancestry and ethnicity data to the system and built the associated ETL data flows.

Periodically, the functionally of the IPR's interface was tested as new features were implemented into the suite. A new functionality for exporting IPR reports was developed.

Immunobiological test results generated through NMDP/CIBMTR approved studies and reported to the NMDP are summarized in Table 7. These data will be used for testing, validation, and population of the IPR database.

Table 4. Immunobiology typing projects utilizing NMDP samples and contributing data to the IPR database

Study Title	Investigator	Number of Samples	Genes of interest	Testing Method	Data Submitted
NK Cells, Their Receptors and Unrelated Donor Transplant[9,10]	J. Miller	2300 pairs	KIR	RT-PCR, FACS, SSO, MALDI-TOF	Yes
Survey of Diversity of Immune Response Genes in Unrelated Hematopoietic Stem Cell Transplantation	C. Hurley	40 Pairs	Cytokine and KIR	SBT	Yes
Candidate Gene Study to Examine the Impact of Chemokine and Chemokine Receptor Gene Polymorphisms on the Incidence and Severity of Acute and Chronic GVHD[11]	R. Abdi	1300 pairs	CCL1, CCL2, CCR5, CCR2, CX3CR1	Taqman PCR	Yes
Functional Significance of Killer Ig-like Receptor (KIR) Genes in HLA Matched and Mismatched Unrelated HCT[12]	B. Dupont, K. Hsu	2000 pairs	KIR	SSP	Yes
Functional Significance of Cytokine Gene Polymorphism in Modulation Risk of Post-Transplant Complications	E. Petersdorf	2500 pairs	>30 Immune response genes	Taqman PCR	Yes

Study Title	Investigator	Number of Samples	Genes of interest	Testing Method	Data Submitted
Identification of Functional SNPs in Unrelated HCT[13,14]	E. Petersdorf	3500 pairs	Entire MHC region	Taqman PCR	In Process
Use of Female Donors with Pre-existing Antibody to H-Y Antigen will Result in Robust Serologic Response to H-Y Antigens in Male HSC transplantation Recipients	D. Miklos	288 pairs	H-Y Antigen	ELISA, protein array	Yes
Multiplexed Genotyping of Human Minor Histocompatibility Antigens (mHAg): Clinical Relevance of mHAg Disparity in Stem Cell Transplantation[15]	T. Ellis	730 pairs	mHAg	Allele-specific Primer Extension	Yes
Genetic Polymorphisms in the Genes Encoding Human Interleukin-7 Receptor-a: Prognostic significance in Allogeneic Stem Cell Transplantation[16]	K. Muller	851 pairs	IL-7	Taqman PCR	Yes
The Effect of Non-Inherited Maternal Antigens in Cord Blood Transplantation[17]	L. Baxter-Lowe	102 pairs	HLA	SBT	Yes
Detection of HLA Antibody in Single Antigen HLA-Mismatched Unrelated Donor Transplants	S. Arai, D. Miklos	200 pairs	Anti-body	ELISA, Protein array	Yes
Detection of Donor-Directed, HLA-Specific Alloantibodies in Recipients of Unrelated Stem Cell Transplantation and Their Relationship to Graft/Patient Outcome[18]	R. Bray	111 pairs	Anti-bodies	Flow cytometry	Yes
Genome-wide Association in Unrelated Donor Transplant Recipients and Donors: A Pilot Study	R. Goyal	858 pairs	> 600,000 Genome wide SNPs	Human 610 - Quad V1 arrays	In process
SNPs in the p53 Pathway and Outcomes in URD HCT	B. DuPont	1500 pairs	p53, ATM, MDM2 and p21/Waf1	Taqman	In process

Study Title	Investigator	Number of Samples	Genes of interest	Testing Method	Data Submitted
Association of Donor and Recipient Gene Polymorphisms of Drug and Innate Immune Response with Outcomes after URD HCT	V. Rocha	725 pairs	GSTP, GSTT, GSTM, UGT CD14, TIRAP, and NALPs	Taqman	In process
To Develop and Test a Prognostic Index for Survival in CML URD HCT[19]	A. Dickinson	1100 pairs	TNF, IL-1RA and IL-10	Taqman	Yes
Evaluation of TGF-β1 Promoter and Signal Peptide Polymorphisms as Risk Factors for Renal Dysfunction in HCT Patients Treated with Cyclosporine A [20]	R. Shah	400 samples	TGF-β1	Taqman	Yes
Donor and Recipient Telomere Length as Predictors of Outcomes after Hematopoietic Stem Cell Transplant in Patients with Acquired Severe Aplastic Anemia	S. Gadalla	650 samples	Telomere length and Telomerase Polymorphisms	Taqman	In process
Development of a GVHD Prevention Biodiagnostic Test	R. Somogyi	450 samples	Gene Expression Array	Array	In process
Genetic polymorphisms and HCT related mortality Re: Pre-HCT conditioning in matched unrelated donor HCT	T. Hahn	>4,000 pairs	GWAS	Array	In process
Impact of CTLA4 SNPs on outcome after URD transplant	M. Jagasia	1,200 pairs	CTLA-4 SNPs	Taqman	In process
KIR genotyping and immune function in MDS patients prior to unrelated donor transplantation	A. E.Warlick and J. Miller	970 samples	KIR genotype, expression and cellular function	SSP, flow cytometry and cellular assays	In process
Plasma YKL-40 anc CHI3LI genotype to predict mortality after unrelated donor HCT	B. Kornblit	800 pairs	YKL-40 plasma levels and CHI3LI SNPs	ELISA and Taqman	In process

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Study Title	Investigator	Number of Samples	Genes of interest	Testing Method	Data Submitted
Natural killer cell genomics and outcomes after allogeneic transplantation for lymphoma	V. Bachanova, J. Miller, D. Weisdorf and L. Burns	800 pairs	KIR genotype, expression and cellular function	SSP, flow cytometry and cellular assays	In process
Effect of genetic ancestry matching on HSCT outcomes	A Madbouly, M. Maiers and N. Majhail	2300 pairs	Ancestry Informative Markers	Taqman	In process
Impact of MHC Class I chain related polymorphisms on HCT outcomes	M. Askar and R. Sobecks	700 pairs	MICA genotypes	Taqman	In process
Impact of donor signal-regulatory protein alpha polymorphism on HCT outcome	A. Gassas, J. Danska and S. Rajakumar	400 pairs	SIRP-α SNPs	Taqman	In process
Discrepancy analysis of microsatellite loci as a proxy measure for ancestral differentiation	J. Harvey, C. Steward and V. Rocha	800 pairs	Microsatellites and STR	Taqman	In process

II.D. Clinical Research in Transplantation – Hypothesis 1:

Clinical research in transplantation improves transplant outcomes and supports preparedness for a contingency response.

Aim D.1.1: Observational Research, Clinical Trials, and NIH Transplant Center

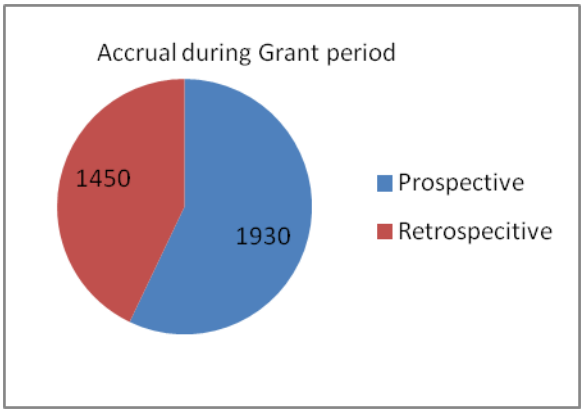
Resource for Clinical Investigations in Blood and Marrow Transplantation (RCI BMT)

The RCI BMT continued to work towards its goal to provide an avenue for investigators to obtain statistical and data management support for prospective trials and projects in HCT. The following key activities were completed during this grant:

- Clinical Trials Advisory Committee (CTAC) held its annual in-person meeting and a mid-year meeting during this grant period. The annual meeting occurred during the Tandem meetings, in February 2012 and the mid-year meeting occurred via conference call in July 2012. This committee has been charged with providing scientific review and recommendations on clinical trial proposals. At its in-person meeting, no proposals were received however a review was completed of the current trials and projects being supported by the RCI BMT. At its July 2012 meeting, the committee reviewed two proposals. The CTAC did not approve either proposal however provided recommendations to strengthen their projects and invited the proposers to resubmit if interested.
- In September 2011, the Adult Double Cord protocol for patients with hematologic malignancies met its accrual goal of 56 patients. Staff continued working with sites to ensure all data was submitted, data queries were addressed and performed site monitoring visits during this grant. An abstract was submitted and accepted for Oral presentation at the February 2013 BMT Tandem meetings. The following conclusions were presented:
    - DCBT is a viable alternative treatment for adults with high-risk acute leukemia/ MDS that extends transplant access to those lacking a matched related or unrelated donor.
    - Early TRM was high**;** Potential contributors were
        - too liberal organ function & performance status eligibility criteria
        - too low TNC cut-off of 1.5
        - q12 MMF stopping at day 45
    - Chronic GVHD and relapse were low
    - Immune recovery analysis continues however plateau on survival curve suggests immune reconstitution in survivors

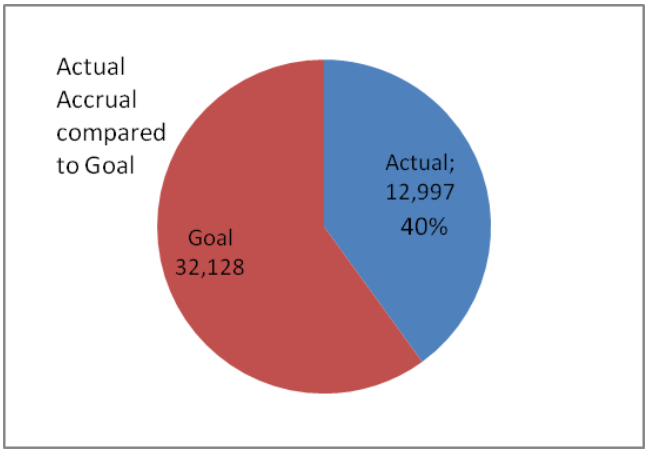
- The Long-Term Donor Follow up (LTDFU) study opened October 1, 2010. Accrual to this study includes donors who previously donated (retrospective) in addition to donors who are donating currently (prospective). During this grant a total of 3380 donors enrolled in this study, a breakdown of retrospective and prospective is in the graphic below:

Figure 20. Long-Term Donor Follow up study accrual



As of the end of this grant, a total of 12,997 donors had consented to participate; 3871 prospective and 9126 retrospective as can be seen in the graphic below. This is 40% of the goal of 32,128. Donors once enrolled receive a follow up call/assessment 1 year post donation/enrollment and then every other year. A total of 2,971 assessments were completed during this grant.

Figure 21. Long-Term Donor Follow up study accrual as compared to study goal



- Discussions and planning sessions occurred during this grant related to the following two projects: a) comprehensive system for management of activities and studies within the

SRG and b) clinical trial management system (CTMS) to coordinate operational and administrative activities. These sessions included business system requirement gathering, identification and assessment of external systems, request for proposal process, and recommendations for solution. A final decision is currently being considered in consort with CIT and CIBMTR leadership.

- In collaboration with other leaders in the field, CIBMTR contributed substantially to the successful research proposal to the CMS to collect outcomes data for myelodysplastic syndrome, to demonstrate benefits of HCT to both survival and quality of life. In order to answer the objectives of this study, comprehensive research data forms are required on all accrued recipients. A system is in place to only select a limited number of these forms for general research purposes due to limited funds. The addition of these forms to the selection criteria does not replace but adds to the required forms and thus the funds required for payments. Form payment for 90 recipients enrolled in this CMS-MDS study were covered during this grant.

Cord Blood Research Activity

Defining Biomarkers Associated with Cord Blood Engraftment

Testing was completed for the validation phase for the study investigating biomarkers associated with cord blood engraftment in order to ensure the generation of consistent results at both testing sites of Duke and St. Louis Cord Blood Bank (SLCBB). Testing involved the following:

- Five new segments from five different cord blood units (CBU) processed at SLCBB were tested.
- 29 segments from 29 different CBUs were tested by SLCBB. These 29 segments were part of the initial validation between Duke and MD Anderson Cancer Center (MDACC). Therefore, the results already exist for Duke. The data from Duke was compared to SLCBB.

Table 5. Inter-laboratory results assessing variation in the testing results for the target cells of interest (ALDHbr %CD45 viable cells) in the cord blood engraftment biomarker study

Dataset (# of segments tested at each site)	Measurement	Subject variance	Within subject variance	Reliability
(N=5)	ALDHbr (% viable CD45)	0.059	0.016	**78.8%**
(N=29)	ALDHbr (% viable CD45)	0.062	0.033	**65.4%**

The reliability of both data sets did not satisfy the pre-established acceptability threshold of ≥ 80%. An investigation into the possible areas where inter-laboratory variation was being introduced involved the following next steps and results:

- The two laboratories will swap raw flow cytometry data and re-gate.
  - These data indicated more consistent reliability for most of the ALDHbr measurements than previously recorded when each center used its own flow data.
- Once re-gating was completed, histograms from each lab were compared side-by-side to look for variance in gating strategies.
  - From this comparison, it was noted that the gating strategies were different between Duke and SLCBB pertaining to live/dead cells.
- Ran reliability analyses between the SLCBB and MDACC datasets for the 29 segments tested.
  - These indicated poor agreement between SLCBB and MDACC.

The study was subsequently closed for the following reasons:

- Failure to meet the threshold of acceptable results (inter-laboratory reliability ≥ 80%) in the validation phase and the post validation phase of the study.
- The assay was determined to be tedious and cumbersome by a study participant.
- As a result, a study participant and an external potential participant determined a lack of value in the assay and expressed a lack of interest in continuing any type of optimization.

Anti-HLA Donor Specific Antibody Study

Work continued on the development of the anti-HLA donor specific antibody study of recipients transplanted with CBUs.

- Potential pairs eligible for inclusion in the study were identified.
- Cohort and graft failure cases were identified.
- Next steps included protocol finalization and laboratory procurement.

CBU release criteria study

Recent studies indicate CFU and CD34 viability are of the highest importance when predicting engraftment.[21,22] Currently the FDA recommends only pre-cryopreservation potency analysis of UCB to ensure quality.[23] However, because cryopreservation and storage can also affect the quality of the UCB, there is evidence to suggest that the addition of post-cryopreservation quality assessment be conducted.[24] The 4th edition of NetCord-FACT International Cord Blood Standards recommends an additional post-cryopreservation CFU to assess these affects.[25] However, in FY13 surveys conducted by the NMDP Cord Blood Advisory Group (CBAG) to determine post-cryopreservation/pre-release quality assessment practices of NMDP member cord

blood banks (CBB) indicated little inter-bank consensus on the number of and type of assays performed prior to release of the UCB unit (Table 11). Of the 19 participating CBBs, 84% have established UCB unit release testing criteria. 53% perform CFU, 47% perform TNC, and 37% perform CD34 analysis. 67% perform TNC viability, while 44% perform CD34+ cell viability. A majority (86% of 14 CBBs who answered the question) of CBBs performs overall viability; however, the methodology (7AAD, trypan blue, other) varies between banks. Most CBBs (73%) assay contiguous segments, but 50% do not have a validated segment thaw protocol. Of the 12 CBBs that answered the question of whether they have not released a UCB unit based on release testing results, 3 (25%) indicated in the positive. Strikingly, the range of what is considered an acceptable result, if defined at all, varied highly between CBBs for the various assays reported.

Table 6: UCB release testing criteria practices among NMDP network CBBs

	Parameter		Sample		Sample Handling			Acceptable Results
	Yes (%)	No (%)	Segment (%)	Vial (%)	Thaw (%)	Thaw and Dilute (%)	Thaw and Wash (%)	
TNC Recovery	9 (47)	10 (53)	5 (56)	4 (44)	5 (63)	3 (37)	0 (0)	>50-80%
MNC Recovery	3 (17)	15 (83)	3 (100)	0 (0)	1 (33)	2 (67)	0 (0)	>80%
CD34+ Recovery	7 (37)	12 (63)	5 (71)	2 (29)	4 (57)	2 (29)	1 (14)	>80%
Viability TNC	12 (67)	6 (33)	9 (75)	3 (25)	8 (62)	4 (31)	1 (7)	>40-75%
Viability CD34+	8 (44)	10 (56)	6 (75)	2 (25)	5 (56)	2 (22)	2 (22)	>80-85%
CFU	10 (53)	9 (47)	9 (90)	1 (10)	5 (45)	5 (45)	1 (10)	growth
Other: ALDHbr	1 (6)	16 (94)	1 (100)	0 (0)	0 (0)	0 (0)	1 (100)	>0.1% CFU

It is, therefore, important to study the role of post-cryopreservation UCB CFU characteristics on transplant outcomes. The CBAG research sub-committee submitted a proposal to the CIBMTR Graft Sources Working Committee for review at the 2013 BMT Tandem Meetings entitled, "Cord blood unit release testing criteria and impact on the transplantation outcome." The primary aim of the study is to determine the impact of UCB CFU testing at the time of release on transplantation outcome. This study will focus on the CFU assay because post-thaw growth is indicative of overall unit suitability and approximately 50% of NMDP network CBBs perform the assay pre-release. The study proposal was presented to the Graft Sources and Manipulation Working Committee meeting during Tandem 2013. The committee members assigned a low priority score and were unable to accept the proposal. The Cord Research Subcommittee met to discuss the future of the study and determined to continue without the support of the Graft Sources and Manipulation Working Committee.The study proposal was presented to the Cord Blood Advisory Group in June 2013. The committee members agreed to move forward with the study.

After the study proposal was presented to the Cord Blood Advisory Group in June 2013, a call for participation was distributed to NMDP Network cord blood banks. A study group was created based on positive participation responses from cord blood banks that perform post-cryopreservation CFU. The study group held a conference call to discuss further protocol development, data submission, and contract creation. Further work on the study will continue into the next grant period.

NIMA Analysis

Work began on a non-inherited maternal antigen (NIMA) analysis assessing the effect of high-resolution (HR) HLA typing at A, B, C, DRB1, and DQB1 versus the presence or absence of a NIMA match for recipients of a cord blood transplant.

- Using the Eurocord-NMDP cohort from a previous study, HR typing was determined for cases where it was present. For cases where HR typing was not available, imputation was performed.

NIH Search Support

The National Institutes of Health (NIH) has been accepted as an NMDP transplant center since 2007. Prior to that time, the NIH, representing our Nation's premier medical research endeavor, was not applying their considerable problem-solving skills to issues surrounding unrelated donor transplantation. The NMDP, with ONR support, set out to remedy that deficiency by entering into collaboration with NIH. This collaboration has been extremely successful.

The NMDP is collaborating with intramural NIH transplant programs from the NCI, the NHLBI and the NIAID. These programs are investigating alternative approaches in unrelated donor transplantation to improve patient outcomes. The actual transplants and the investigational portions of each transplant (i.e., the research protocols) are supported entirely with NIH funds. Navy funding supplies support for donor identification, selection, and collection. NMDP donors are not research subjects on these protocols because the donors are making standard donations for accepted transplant indications. The research component of these transplants is conducted entirely by NIH intramural program staff and funded entirely with NIH dollars. The NMDP provided support for the collection of 35 products (25 PBSC, 9 CBU, and 1 therapeutic T cell) under the grant.

CIBMTR Observational Research

Support of the Observational Research program included statistical hours for managing studies within the Immunobiology (see section IID1.3 below), GVHD, and Graft Sources Working Committees. During this grant period staff performed proposal review, protocol development, data preparation, data analysis, and manuscript preparations. Details regarding the Immunobiology activities can be found in IID1.3 below. The GVHD and Graft Sources Working Committees published 5 manuscripts.[25-30] During the grant period, staff performed various other functions on over 20 other studies.

CIBMTR IT Activity

FormsNet3

The foundational work for **FormNet3** electronic CIBMTR forms data capture application was completed for implementation in December 2012. This period was significant to the implementation of the new Form Definition Manager in preparation for the Quality Assurance test phase. This tool provided a non-code rendition of new forms, provided access to curated metadata information and was the mechanism for entering form validation and navigation. An additional technical upgrade was completed on the database to prepare for the FormsNet 3 Recipient release in December 2012.

Some overall benefits of the FormsNet 3 application include:

- Provides greater flexibility to improve data quality and responsiveness to user needs.
- Enhanced performance by improving speed, usability, consistency and usefulness of forms access, user data entry, and validations
- Improved user experience/usability by offering real-time data validations, rules, control of data entry “flow”, error handling and messaging, and “smart navigations” (from form-to-form or from field-to-field on the same form), auto population of key fields

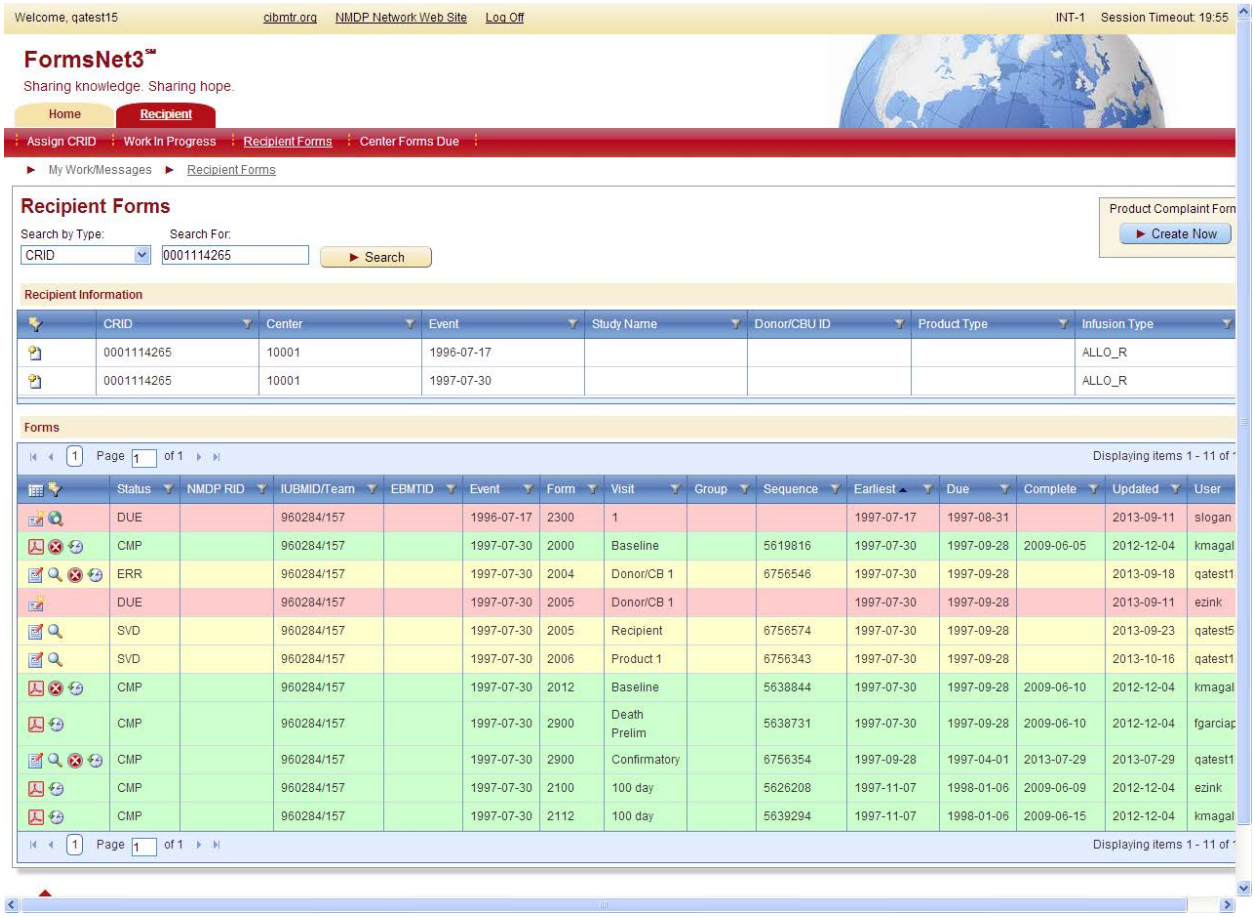
- Improved data quality- by enabling data entry to be as easy, consistent, accurate, and fast as possible

Some key features of the FormsNet 3 application include:

- New Site features
  - Flexibility, site search, expanded browser support
- Forms Entry improvements
  - Faster loading of pages, improved layout, and navigation
  - Auto-population, field (rather than form) level saving
- Validation improvements
  - Display validation rules, over-ride improvements, validation across forms

The figure below is a screen shot of the Recipient forms grid (Fig. 22), which enables FormsNet 3 users to identify which forms are in the queue for a given recipient. The screen also shows the tabs, menu bar and breadcrumbs, which help facilitate one-click navigation. The Quick links feature enables users to access the external websites for CIBMTR (www.cibmtr.org) and NMDP network website. The application was upgraded to have a more modern look and feel than FormsNet 2 and to support the ability to add key features such as autopopulation, improved navigation and validation, and overall increased performance:

Figure 22. Screen Shot of FormsNet3 Application (Recipient Forms Grid)



The use of FormsNet has continued to result in increases in the number of forms submitted electronically.

- More than 338 centers used FN2/3 to enter data in 2012
- From Oct 2011 – March 2012, the number of forms submitted electronically through FormsNet and AGNIS was 73,989, which accounted for 91.66% of all submissions during this time period
- Most of the other ~9% are forms that must be sent on paper; these include supporting documents

AGNIS

A Growable Network Information System (AGNIS) support for curated forms grew to 15 during this funding period. These forms are:

- Form 2000 - Recipient Baseline Data
- Form 2004 - Infectious Disease Markers
- Form 2005 - Confirmation of HLA Typing
- Form 2006 – HSCT Infusion FormForm2018 - Hodgkin and Non-Hodgkin Lymphoma Pre-HSCT data
- Form 2007 - Cord Blood Unit – SCTOD Data Requirements
- Form 2100 - 100 Days Post-HSCT Follow-up Form
- Form 2118 - Hodgkin and Non-Hodgkin Lymphoma Post-HSCT data
- Form 2200 - Six Months to Two Years Post-HSCT Data
- Form 2300 - Yearly Follow-Up for Greater Than 2 Years Post-HSCT data
- Form 2400 - Pre-Transplant Essential Data
- Form 2450 - Post-Transplant Essential Data
- Form 2451 - Chimerism Studies
- Form 2455 - Selective Post-Transplant Essential Data
- Form 2804 – Unique ID form
- Form 2900 - Recipient Death Data

Additional forms now supported include the form 2000 (Recipient Baseline data), the Form 2007 (Cord Blood Unit – SCTOD Data Requirements), and 2804 (unique ID form).

- The Form 2000 is used to document Pre-HCT recipient status evaluation and the actual preparative regimen received.
- Form 2007 is completed for Non-NMDP Cord Blood products, which could be domestic or International. This form is intended to fill in the gaps where the cord blood bank does not provided the full IDMs, HLA typing, product collection/storage/shipment information for Non-NMDP cord blood products.
- The 2804 (unique ID form) will avoid duplication of recipient records across transplant programs, particularly when situations exist where sequential HSCTs occur at different institutions.

Capabilities for EBMT submission were implemented for the pre Ted and CRID form. 2000 records were received by July 2012. One key component leading to the successful submissions of the EBMT forms has been the implementation of an automated batch submission process. This process eliminates the need for forms to be submitted manually on a 1 by 1 basis.

Additional mapping and development continues on data points to support submission of forms 2400, 2450, and 2006.

Centers participating in AGNIS submission grew to 4. This list includes MD Anderson, Moffitt, EBMT, and Remedy Informatics.

Management Reporting
A number of Management Reports were also released to support Cord Blood IND, Event reporting, internal management needs as well as report enhancements and bug fixes. These include the following new reports: Reimbursement Future Liability, 09-MRD Sample Status, RDSafe Forms Completed, 10-CBA Recipient Data, SRG-LTDFU Assessment Forms Cmp by DID, 10-CBA Study Exit, 09-MRD Payment, BMT CTN Accrual Count by Center, BMT CTN Accrual Count by Protocol, LTDFU Current Enrollments. Bug fixes/enhancements were made to the following areas: Reimbursement, Recipient Continuous Process Improvement, Adverse Events, RDSafe study, Minimal Residual Disease study, and Metrics.

Aim D.1.2: Research with NMDP Donors

No funding was requested under this aim for the 0142 budget cycle.

Aim D.1.3: Expand Immunobiology Research

Grant funds supported significant outreach efforts by the IBWC leadership to increase exposure for the IBWC to researchers involved in immunobiology and immunogenetics. The IBWC leadership had a presence at the American Society of Hematology, BMT Tandem, European Group for Blood and Marrow Transplant, European Federation of Immunogenetics, and Cord Blood Symposium annual meetings.

In addition, the IBWC co-scientific director and biostatistician participated in the 16th International Histocompatibility Workshop in May 2012. The CIBMTR IBWC plays an integral role in the IHIW HCT component by supporting data and research sample sharing for all U.S. transplant centers that participate in the CIBMTR and NMDP Research Repository. The co-scientific director also serves on the IHIW-HCT steering committee.

Support permitted the committee to maintain a strong performance record with 6 abstracts presented, 10 manuscripts published, and 3 manuscripts submitted for publication. The IBWC reviewed and accepted 8 proposals during the BMT Tandem meetings in February 2013. The full IBWC research portfolio and publications are continually updated on the CIBMTR Web site.

Ten manuscripts were published:

1. Petz LD, Redei I, Bryson Y, Regan D, Kurtzberg J, Shpall E, Gutman J, Querol S, Clark P, Tonai R, Santos S, Bravo A, Spellman S, Gragert L, Rossi J, Li S, Li H, Senitzer D, Zaia J, Rosenthal J, Forman S, Chow R. Hematopoietic cell transplantation with cord blood for cure of HIV infections. Biology of Blood and Marrow Transplantation: Journal of the American Society for Blood and Marrow Transplantation. 2013 Mar 1; 19(3):393-397. doi:10.1016/j.bbmt.2012.10.017. Epub 2012 Oct 23.

2. Petersdorf EW, Malkki M, Hsu K, Bardy P, Cesbron A, Dickinson A, Dubois V, Fleischhauer K, Kawase T, Madrigal A, Morishima Y, Shaw B, Spellman S, Spierings E, Stern M, Tiercy JM, Velardi A, Gooley T. 16th IHIW: International Histocompatibility Working Group in hematopoietic cell transplantation. International Journal of Immunogenetics. 2013 Feb 1; 40(1):2-10. doi:10.1111/iji.12022. Epub 2012 Dec 28.

3. Pidala J, Wang T, Haagenson M, Spellman SR, Askar M, Battiwalla M, Baxter-Lowe LA, Bitan M, Fernandez-Viña M, Gandhi M, Jakubowski AA, Maiers M, Marino SR, Marsh SG, Oudshoorn M, Palmer J, Prasad VK, Reddy V, Ringden O, Saber W, Santarone S, Schultz KR, Setterholm M, Trachtenberg E, Turner EV, Woolfrey AE, Lee SJ, Anasetti C. Amino acid substitution at peptide- binding pockets of HLA class I molecules increases risk of severe acute GVHD and mortality. Blood. Epub 2013 Aug 27.

4. Shamim Z, Spellman S, Haagenson M, Wang T, Lee SJ, Ryder LP, Müller K. Polymorphism in the interleukin-7 receptor-alpha and outcome after allogeneic hematopoietic cell transplantation with matched unrelated donor. Scandinavian Journal of Immunology. 2013 Aug 1; 78(2):214-220. doi:10.1111/sji.12077. Epub 2013 May 21.

5. Morishima Y, Kawase T, Malkki M, Morishima S, Spellman S, Kashiwase K, Kato S, Cesbron A, Tiercy J-M, Senitzer D, Velardi A, Petersdorf EW. Significance of ethnicity in the risk of acute graft-versus-host disease and leukemia relapse after unrelated donor hematopoietic stem cell transplantation. Biology of Blood & Marrow Transplantation. 2013 Aug 1; 19(8):1197-1203. doi:10.1016/j.bbmt.2013.05.020. Epub 2013 Jun 6.

6. Isobe N, Gourraud PA, Harbo HF, Caillier SJ, Santaniello A, Khankhanian P, Maiers M, Spellman S, Cereb N, Yang S, Pando MJ, Piccio L, Cross AH, De Jager PL, Cree BA, Hauser SL, Oksenberg JR. Genetic risk variants in African Americans with multiple sclerosis. Neurology. 2013 Jul 16; 81(3):219-227. doi:10.1212/WNL.0b013e31829bfe2f. Epub 2013 Jun 14. PMC3770164.

7. Hurley CK, Woolfrey A, Wang T, Haagenson M, Umejiego J, Aljurf M, Askar M, Battiwalla M, Dehn J, Horan J, Oudshoorn M, Pidala J, Saber W, Turner V, Lee SJ, Spellman SR. The impact of HLA unidirectional mismatches on the outcome of myeloablative hematopoietic stem cell transplantation with unrelated donors. Blood.

2013 Jun 6; 121(23):4800-4806. doi:10.1182/blood-2013-01-480343. Epub 2013 May 1. PMC3674677.

8. Petersdorf EW, Malkki M, Horowitz MM, Spellman SR, Haagenson MD, Wang T. Mapping MHC haplotype effects in unrelated donor hematopoietic cell transplantation. Blood. 2013 Mar 7; 121(10):1896-1905. doi:10.1182/blood-2012-11-465161. Epub 2013 Jan 10. PMC3591807.

9. Fernández-Viña MA, Klein JP, Haagenson M, Spellman SR, Anasetti C, Noreen H, Baxter-Lowe LA, Cano P, Flomenberg N, Confer DL, Horowitz MM, Oudshoorn M, Petersdorf EW, Setterholm M, Champlin R, Lee SJ, de Lima M. Multiple mismatches at the low expression HLA loci DP, DQ, and DRB3/4/5 associate with adverse outcomes in hematopoietic stem cell transplantation. Blood. 2013 May 30; 121(22):4603-4610. doi:10.1182/blood-2013-02-481945. Epub 2013 Apr 17. PMC3668493.

10. Dobbelstein C, Ahn KW, Haagenson M, Hale GA, van Rood JJ, Miklos D, Waller EK, Spellman SR, Fernandez-Viña M, Ganser A, Aljurf M, Bornhaeuser M, Gupta V, Marino SR, Pollack MS, Reddy V, Eder M, Lee SJ. Birth order and transplantation outcome in HLA-identical sibling stem cell transplantation: an analysis on behalf of the Center for International Blood and Marrow Transplantation. Biology of Blood & Marrow Transplantation. 2013 May 1; 19(5):741-745. doi:10.1016/j.bbmt.2013.01.020. Epub 2013 Feb 1.

Three manuscripts were submitted:

1. Mary Eapen, et al., Impact of allele-level HLA matching on outcomes after myeloablative single unit umbilical cord blood transplantation for hematologic malignancy. Submitted to Blood.

2. Katharina Fleischhauer, et al., Risk-associations between HLA-DPB1 T cell epitope matching and outcome of unrelated hematopoietic cell transplantation are independent from HLA-DPA1. Submitted to Blood.

3. Effie Petersdorf, et al., HLA-C expression levels define permissible mismatches in hematopoietic cell transplantation. Submitted to Nature Medicine.

Six abstracts were submitted and accepted:

1. Sarah Cooley, et al., Recipient HLA-C1 enhances the clinical advantage of killer-cell immunoglobulin-like receptor B haplotype donors in myeloablative unrelated transplantation for acute Myelogenous leukemia. ASH 2013 annual meeting, accepted for oral presentation.

2. John Koreth, et al., HLA-mismatch is associated with worse outcomes after unrelated donor reduced intensity conditioning hematopoietic cell transplantation: A CIBMTR Analysis. ASH 2013 annual meeting, accepted for oral presentation.

3. Salyka Sengsayadeth, et al., Cytotoxic T lymphocyte antigen 4 (CTLA4) single nucleotide polymorphisms do not impact outcomes after unrelated donor transplant: A CIBMTR Analysis. ASH 2013 annual meeting, accepted for oral presentation.

4. Michelle Gleason, et al., A novel CD16xCD33 bispecific killer cell engager (BiKE) mediates a double hit for natural killer (NK) cells to target DC33+ myelodysplastic syndrome (MDS) cells and myeloid derived suppressor cells (MDSC) at all disease stages. ASH 2013 annual meeting, accepted for oral presentation.

5. Ronald Sobecks, et al., Influence of killer immunoglobulin-like receptor (KIR) and HLA genotypes on outcomes after reduced-intensity conditioning allogeneic hematopoietic stem cell transplantation for patients with AML and MDS: A report from the CIBMTR Immunobiology Working Committee. ASH 2013 annual meeting, accepted for oral presentation.

6. Payal Khincha, et al., Evaluating the utility of telomere length measurement by qPCR as a diagnostic test for dyskeratosis congenita. ASH 2013 annual meeting, accepted for poster presentation.

Attachment A – References

1. Beduhn E, Lazaro A, Lebedeva T, et al. Deletion of unconfirmed rare alleles, C*03:12 and C*15:20. Poster presentation at the 2012 ASHI Meetings. Human Immunology 2012; 73(Suppl): 137. Abstract 140-P.

2. Kempenich JH, Howe K, Maus T, et al. HLA-A,B only typed donors: an untapped resource. Poster presentation at the 2012 ASHI Meetings Human Immunology 2012; 73(Suppl): 145. Abstract 154-P.

3. Robinson J, Pollack J, Walts A, et al. An XML export of the IMGT/HLA database. Human Immunol 2012; 73(s): Abstract 189-P.

4. Robinson J, Pollack J, Walts A, et al. An XML export of the IMGT/HLA database. Tissue Antigens 2012; 79(6): Abstract P281.

5. Milius RP, Shabo A, Pollack J, et al. HL7 implementation of silver standard principles for reporting HLA typing. Tissue Antigens 2012; 79(6): Abstract P279.

6. Milius RP, Mack SJ, Hollenbach JA, Pollack J, Heuer ML, Gragert L, Spellman S, Guethlein LA, Trachtenberg EA, Cooley S, Bochtler W, Mueller CR, Robinson J, Marsh SG, Maiers M. Genotype List String: a grammar for describing HLA and KIR genotyping results in a text string. Tissue Antigens. 2013 Aug;82(2):106-12. doi: 10.1111/tan.12150.

7. Hermanson J, Dehn J, Kempenich J, et al. Young male donors provide the best chance of meeting requested cell dose for PBSC and bone marrow transplantation. Oral presentation at the 2013 BMT Tandem Meetings. Biol Bone Marrow Transplant 2013; 19(2s): S117.

8. Dehn J, Kempenich J, Boo M, Setterholm M. How Much is Enough? Ethical Consideration for the Depletion of Large Public Cord Blood Units. Poster presentation at the 2013 BMT Tandem Meetings. BBMT. Biol Bone Marrow Transplant 2013; 19(2s): S285.

9. Cooley S, Weisdorf DJ, Guethlein LA, et al. Donor selection for natural killer cell receptor genes leads to superior survival after unrelated transplantation for acute myelogenous leukemia. Blood 2010.

10. Cooley S, Trachtenberg E, Bergemann TL, et al. Donors with group B KIR haplotypes improve relapse-free survival after unrelated hematopoietic cell transplantation for acute myelogenous leukemia. Blood 2009; 113(3): 726-732.

11. McDermott DH, Conway SE, Wang T, et al. Donor and recipient chemokine receptor CCR5 genotype is associated with survival after bone marrow transplantation. Blood 2010; 115(11): 2311-2318.

12. Venstrom JM, Pittari G, Gooley TA, et al. HLA-C-dependent prevention of leukemia relapse by donor activating KIR2DS1. N Engl J Med 2012; 367(9): 805-816.

13. Petersdorf EW, Malkki M, Horowitz MM, et al. Mapping MHC haplotype effects in unrelated donor hematopoietic cell transplantation. Blood 2013; 121(10): 1896-1905.

14. Petersdorf EW, Malkki M, Gooley TA, et al. MHC-resident variation affects risks after unrelated donor hematopoietic cell transplantation. Sci Transl Med 2012; 4(144): 144ra101.

15. Spellman S, Warden MB, Haagenson M, et al. Effects of mismatching for minor histocompatibility antigens on clinical outcomes in HLA-matched, unrelated hematopoietic stem cell transplants. Biol Blood Marrow Transplant 2009; 15(7): 856-863.

16. Shamim Z, Spellman S, Haagenson M, et al. Polymorphism in the Interleukin-7 Receptor-alpha and Outcome after Allogeneic Hematopoietic Cell Transplantation with Matched Unrelated Donor. Scand J Immunol 2013; 78(2): 214-220.

17. Rocha V, Spellman S, Zhang MJ, et al. Effect of HLA-matching recipients to donor noninherited maternal antigens on outcomes after mismatched umbilical cord blood transplantation for hematologic malignancy. Biol Blood Marrow Transplant 2012; 18(12): 1890-1896.

18. Spellman S, Bray R, Rosen-Bronson S, et al. The detection of donor-directed, HLA-specific alloantibodies in recipients of unrelated hematopoietic cell transplantation is predictive of graft failure. Blood 2011; 115(13): 2704-2708.

19. Pearce KF, Lee SJ, Haagenson M, et al. Analysis of non-HLA genomic risk factors in HLA-matched unrelated donor hematopoietic cell transplantation for chronic myeloid leukemia. Haematologica 2012; 97(7): 1014-1019.

20. Shah R, Selby ST, Yokley B, et al. TNF, LTA and TGFB1 genotype distributions among acute graft-vs-host disease subsets after HLA-matched unrelated hematopoietic stem cell transplantation: a pilot study. Tissue Antigens 2009; 74(1): 50-56.

21. Eapen M, Rubinstein P, Zhang MJ, et al. Outcomes of transplantation of unrelated donor umbilical cord blood and bone marrow in children with acute leukemia: a comparison study. Lancet 2007; 369:1947–54.

22. Spellman S, Hurley CK, Brady C, et al. National Marrow Donor Program Cord Blood Advisory Group. Guidelines for the development and validation of new potency assays for the evaluation of umbilical cord blood. Cytotherapy. 2011; 13(7):848-55.

23. Prasad VK, Mendizabal A, Parikh SH, et al. Unrelated donor umbilical cord blood transplantation for inherited metabolic disorders in 159 pediatric patients from a single center: infl uence of cellular composition of the graft on transplantation outcomes. Blood. 2008; 112:2979–89.

24. Eapen M, Rocha V, Sanz G, et al. Effect of graft source on unrelated donor haemopoietic stem-cell transplantation in adults with acute leukemia: a retrospective analysis. Lancet Oncol. 2010; 11:653–60.

25. Scaradavou A, Smith KM, Hawke R, Schaible A, Abboud M, Kernan NA, et al. Cord blood units with low CD34+ cell viability have a low probability of engraftment after double unit transplantation. Biol Blood Marrow Transplant. 2010; 16:500–8.

26. Battiwalla M, Ellis K, Li P, et al. HLA DR15 antigen status does not impact graft-versus-host disease or survival in HLA-matched sibling transplantation for hematologic malignancies. Biology of Blood & Marrow Transplantation. 2012 Aug 1; 18(8):1302-1308. doi:10.1016/j.bbmt.2012.02.011. Epub 2012 Mar 10.

27. Brunstein CG, Eapen M, Ahn KW, et al. Reduced-intensity conditioning transplantation in acute leukemia: the effect of source of unrelated donor stem cells on outcomes. Blood. 2012 Jun 7; 119(23):5591-5598. doi:10.1182/blood-2011-12-400630. Epub 2012 Apr 10.

28. Scaradavou A, Brunstein CG, Eapen M, et al. Double unit grafts successfully extend the application of umbilical cord blood transplantation in adults with acute leukemia. Blood. 2013 Jan 31; 121(5):752-758. doi:10.1182/blood-2012-08-449108. Epub 2012 Dec 9.

29. Alousi AM, Le-Rademacher J, Saliba RM, et al. Who is the better donor for older hematopoietic transplant recipients: an older-aged sibling or a young, matched unrelated volunteer? Blood. 2013 Mar 28; 121(13):2567-2573. doi:10.1182/blood-2012-08-453860. Epub 2013 Jan 29.

30. Marks DI, Ahn KW, Xiaobo Z, et al. Unrelated umbilical cord blood transplant for adult acute lymphoblastic leukemia in first and second complete remission: a comparison with allografts from adult unrelated donors. Haematologica.doi:10.3324/haematol.2013.094193. Epub 2013 Sep 20.

Attachment B – Published Manuscripts and Abstracts Associated with this Grant

Manuscripts and Book Chapters

1. Majhail NS, Rizzo JD, Lee SJ, Aljurf M, Atsuta Y, Bonfim C, Burns LJ, Chaudhri N, Davies S, Okamoto S, Seber A, Socie G, Szer J, Van Lint MT, Wingard JR, Tichelli A. Recommended Screening and Preventive Practices for Long-Term Survivors after Hematopoietic Cell Transplantation. Hematology-Oncology and Stem Cell Therapy. 2012 JAN 01; doi:10.5144/1658-3876.2012.1. 5:1-30.

2. Majhail NS, Rizzo JD, Lee SJ, Aljurf M, Atsuta Y, Bonfim C, Burns LJ, Chaudhri N, Davies S, Okamoto S, Seber A, Socie G, Szer J, Van Lint MT, Wingard JR, Tichelli A. Recommended Screening and Preventive Practices for Long-Term Survivors after Hematopoietic Cell Transplantation. Revista Brasileira de Hematologia e Hemoterapia. 2012 MAR 01; http://dx.doi.org/10.5581/1516-8484.20120032. 34(2): 109-133.

3. Majhail NS, Rizzo JD, Lee SJ, Aljurf M, Atsuta Y, Bonfim C, Burns LJ, Chaudhri N, Davies S, Okamoto S, Seber A, Socie G, Szer J, Van Lint MT, Wingard JR, Tichelli A. Recommended Screening and Preventive Practices for Long-Term Survivors after Hematopoietic Cell Transplantation. Bone Marrow Transplantation. 2012 MAR 01; doi:10.1038/bmt.1012.5. 47:337-341.

4. Weisdorf D, Cooley S, Devine S, Fehninger T, DiPersio J, Anasetti C, Waller E, Porter D, Farag S, Drobyski W, Defor T, Curtsinger J, Miller J. T cell-depleted partial matched unrelated donor transplant for advanced myeloid malignancy: KIR ligand mismatch and outcome. Biology of Blood & Marrow Transplantation. Epub 2011 Dec 7. [Epub ahead of print]; doi.org/10.1016/j.bbmt.2011.11.024.

5. Hale GA, Shrestha S, Le Rademacher J, Burns LJ, Gibson J, Inwards DJ, Freytes CO, Bolwell BJ, Hsu JW, Slavin S, Isola L, Rizzieri DA, Gale RP, Laport GG, Montoto S, Lazarus HM, Hari PN. Alternate donor hematopoietic cell transplantation (HCT) using reduced-intensity conditioning regimens in non-Hodgkins lymphoma: a report from the CIBMTR Biology of Blood & Marrow Transplantation. Epub 2011 Dec 7. [Epub ahead of print]; doi.org/10.1016/j.bbmt.2011.11.026.

6. Eapen M, Horowitz MM. Alternative donor transplantation for aplastic anemia. American Society of Hematology, Education Program Book. 43-46. 2011 Dec 1;

7. Pearce KF, Lee SJ, Haagenson M, Petersdorf EW, Norden J, Collin MP, Klein JP, Spellman SR, Lowerson SA, Davies SM, Dickinson AM. Analysis of non-HLA genomic risk factors in HLA-matched unrelated donor hematopoietic cell transplantation for chronic myeloid leukemia. Haematologica. [Epub ahead of print] doi:10.3324/haematol.2011.053611. Epub 2012 JAN 22.

8. Battiwalla M, Wang T, Carreras J, Deeg HJ, Ayas M, Bajwa RPS, George B, Gupta V, Pasquini R, Schrezenmeier H, Passweg JR, Schultz KR, Eapen M. HLA-matched sibling transplantation for severe Aplastic anemia: impact of HLA DR15 antigen status on engraftment, graft vs. host disease and overall survival. Biology of Blood & Marrow Transplantation. [Epub ahead of print] doi:10.1016/j.bbmt.2012.02.007. Epub 2012 FEB 28.

9. Fleischhauer K, Shaw BE, Gooley T, Malkki M, Bignon JD, Dubois V, Horowitz MM, Madrigal JA, Morishima Y, Oudshoorn M, Ringdén O, Spellman S, Velardi A, Zino E, Petersdorf EW. Effect of T-cell-epitope matching at HLA-DPB1 in recipients of unrelated-donor haemopoietic-cell transplantation: a retrospective study. Lancet Oncology. 2012 APR 01; doi:10.1016/S1470-2045(12)70071-2. 13(4):366-374. Epub 2012 FEB 15.

10. Kamani NR, Walters MC, Aquino V, Brochstein JA, Chaudhury S, Eapen M, Freed BM, Grimley M, Levine JE, Logan B, Moore T, Panepinto J, Parikh S, Pulsipher MA, Sande J, Schultz KR, Spellman S, Shenoy S. Unrelated donor cord blood transplantation for children with severe sickle cell disease: results of one cohort from the Phase II study from the Blood and Marrow Transplant Clinical Trials Network (BMT CTN). Biology of Blood & Marrow Transplantation. [Epub ahead of print] doi:10.1016/j.bbmt.2012.01.019. Epub 2012 FEB 16.

11. Saber W, Opie S, Rizzo JD, Zhang MJ, Horowitz MM, Schriber J. Outcomes after matched unrelated donor vs. identical sibling hematopoietic cell transplantation (HCT) in adults with acute myelogenous leukemia (AML). Blood. 2012 APR 26; doi:10.1182/blood-2011-09-381699. 119:3908-3916. Epub 2012 FEB 10. [Available on 2013/4/26]

12. Ballen KK, Woolfrey AE, Zhu X, Ahn KW, Wirk B, Arora M, George B, Savani BN, Bolwell B, Porter DL, Copelan E, Hale G, Schouten HC, Lewis I, Cahn JY, Halter J, Cortes J, Kalaycio ME, Antin J, Aljurf MD, Carabasi MH, Hamadan M, McCarthy P, Pavletic S, Gupta V, Maziarz RT, Horowitz MM, Saber W. Allogeneic hematopoietic cell transplantation for advanced polycythemia vera and essential thrombocythemia.. Biology of Blood & Marrow Transplantation. [Epub ahead of print] doi:10.1016/j.bbmt.2012.03.009. Epub 2012 MAR 23.

13. Battiwalla M, Ellis K, Li P, Pavletic SZ, Akpek G, Hematti P, Klumpp TR, Maziarz RT, Savani B, Aljurf MD, Cairo MS, Drobyski WR, George B, Hahn T, Khera N, Litzow MR, Loren AW, Saber W, Arora M, Urbano-Ispizua A, Cutler C, Flowers MED, Spellman SR. HLA DR15 antigen status does not impact graft-versus-host disease or survival in HLA-matched sibling transplantation for hematologic malignancies. Biology of Blood & Marrow Transplantation. [Epub ahead of print] doi:10.1016/j.bbmt.2012.02.011. Epub 2012 MAR 10.

14. Eapen M, Ahn KW, Orchard PJ, Cowan MJ, Davies SM, Fasth A, Hassebroek A, Ayas M, Bonfim C, O'Brien TA, Gross TG, Horwitz M, Horwitz E, Kapoor N, Kurtzberg J, Majhail N, Ringdén O, Szabolcs P, Veys P, Baker KS. Long-term survival and late deaths after hematopoietic cell transplantation for primary immunodeficiency diseases and inborn errors of metabolism. Biology of Blood & Marrow Transplantation. [Epub ahead of print] doi:10.1016/j.bbmt.2012.03.003. Epub 2012 MAR 16.

15. Levine JE, Logan BR, Wu J, Alousi AM, Bolaños-Meade J, Ferrara JLM, Ho VT, Weisdorf DJ, Paczesny S. Acute graft-versus-host disease biomarkers measured during therapy can predict treatment outcomes: a Blood and Marrow Transplant Clinical Trials Network study. Blood. 2012 APR 19; doi:10.1182/blood-2012-01-403063. 119(16):3854-60. Epub 2012 MAR 01.

16. Saccardi R, Freedman MS, Sormani MP, Atkins H, Farge D, Griffith LM, Kraft G, Mancardi GL, Nash R, Pasquini M, Martin R, Muraro P. A prospective, randomized, controlled trial of autologous haematopoietic stem cell transplantation for aggressive multiple sclerosis: a position paper. Multiple Sclerosis Journal. [Epub ahead of print] doi:10.1177/1352458512438454. Epub 2012 MAR 20.

17. Thiel EL, Zhang MJ, Davies SM, Camitta BM, Logan B, Tiedemann K, Eapen M. Comparison of outcomes after HLA-matched sibling and unrelated donor transplantation for children with high-risk acute lymphoblastic leukemia. Blood. [Epub ahead of print] doi:10.1016/j.bbmt.2012.01.007. Epub 2012 MAR 06.

18. Majhail NS, Rizzo JD. Surviving the cure: long term followup of hematopietic cell transplant recipients. Bone Marrow Transplantation. 2013 Sep 1; 48(9):1145-1151. doi:10.1038/bmt.2012.258. Epub 2013 JAN 17.

19. Askar M, Daghstani J, Thomas D, Leahy N, Dunn P, Claas F, Doran S, Saji H, Kanangat S, Karoichane M, Tambur A, Monos D, El-Khalifa M, Turner V, Kamoun M, Mustafa M, Ramon D, Gandhi M, Vernaza A, Gorodezky C, Wagenknecht D, Gautreaux M, Hajeer A, Kashi Z, Fernandez-Vina M. 16(th) IHIW: global distribution of extended HLA haplotypes. Int J Immunogenet. 2013 Feb;40(1):31-8. doi: 10.1111/iji.12029.

20. Loren AW, Brazauskas R, Chow EJ, Gilleece M, Halter J, Jacobsohn DA, Joshi S, Pidala J, Quinn GP, Wang Z, Apperley JF, Burns LJ, Hale GA, Hayes-Lattin M, Kamble R,

Lazarus H, McCarthy PL, Reddy V, Warwick AB, Bolwell BJ, Duncan C, Socie G, Sorror ML, Wingard JR, Majhail NS. Physician perceptions and practice patterns regarding fertility preservation in hematopoietic cell transplant recipients. Bone Marrow Transplantation. 2013 Aug 1; 48(8):1091-1097. doi:10.1038/bmt.2013.13. Epub 2013 FEB 18.

21. Hale GA, Arora M, Ahn KW, He W, Camitta B, Bishop MR, Bitan M, Cairo MS, Chan K, Childs RW, Copelan E, Davies SM, Perez MA, Doyle JJ, Gale RP, Vicent MG, Horn BN, Hussein AA, Jodele S, Kamani NR, Kasow KA, Kletzel M, Lazarus HM, Lewis VA, Myers KC, Olsson R, Pulsipher M, Qayed M, Sanders JE, Shaw PJ, Soni S, Stiff PJ, Stadtmauer EA, Ueno NT, Wall DA, Grupp SA.. Allogeneic hematopoietic cell transplantation for neuroblastoma: the CIBMTR experience. Bone Marrow Transplantation. 2013 Aug 1; 48(8):1056-1064. doi:10.1038/bmt.2012.284. Epub 2013 FEB 18. PMC3661721.

22. Ayas M, Saber W, Davies SM, Harris RE, Hale GA, Socie G, LeRademacher J, Thakar M, Deeg HJ, Al-Seraihy A, Battiwalla M, Camitta BM, Olsson R, Bajwa RS, Bonfim CM, Pasquini R, Macmillan ML, George B, Copelan EA, Wirk B, Al Jefri A, Fasth AL, Guinan EC, Horn BN, Lewis VA, Slavin S, Stepensky P, Bierings M, Gale RP. Allogeneic hematopoietic cell transplantation for fanconi anemia in patients with pretransplantation cytogenetic abnormalities, myelodysplastic syndrome, or acute leukemia. Journal of Clinical Oncology. 2013 May 1; 31(13):1669-1676. doi:10.1200/JCO.2012.45.9719. Epub 2013 APR 1. PMC3635221.

23. Fernandez-Viña MA, Klein JP, Haagenson M, Spellman SR, Anasetti C, Noreen H, Baxter-Lowe LA, Cano P, Flomenberg N, Confer D, Horowitz MM, Oudshoorn M, Petersdorf EW, Setterholm M, Champlin R, Lee SJ, de Lima M. Multiple mismatches at the low expression HLA loci DP, DQ, DRB3/4/5 associate with adverse outcomes in hematopoietic stem cell transplantation. Blood. 2013 May 30; 121(22):4603-4610. doi:10.1182/blood-2013-02-481945. Epub 2013 APR 17. PMC3668493.

24. Hollenbach JA, Madbouly A, Gragert L, et al. A combined DPA1~DPB1 amino acid epitope is the primary unit of selection on the HLA-DP heterodimer. Immunogenetics 2012; 64(8): 559-569. doi: 10.1007/s00251-012-0615-3. Epub 2012 Apr 13.

25. Foran JM, Pavletic SZ, Logan BR, Agovi-Johnson M, Perez WS, Bolwell BJ, Bornhauser M, Bredeson CN, Cairo MS, Camitta BM, Copelan EA, Dehn J, Gale RP, Biju G, Gupta V, Hale GA, Lazarus HM, Litzow MR, Maharaj D, Marks DI, Martino R, Maiarz RT, Rowe JM, Rowlings PA, Savani BN, Savoie ML, Szer J, Waller EK, Wiernik PH, Weisdorf DJ. Unrelated donor allogeneic transplantation after failure of autologous transplantation for acute myeloid leukemia: a study from the CIBMTR. Biology of Blood & Marrow Transplantation. 2013 Jul 1; 19(7):1102-1108. doi:10.1016/j.bbmt.2013.04.022. Epub 2013 APR 28. PMC3691352.

26. Omondi NA, Ferguson SE, Majhail NS, Denzen EM, Buchanan GR, Haight AE, Labotka RJ, Rizzo JD, Murphy EA. Barriers to hematopoietic cell transplantation clinical trial participation of African-American and black youth with sickle cell disease and their parents. Journal of Pediatric Hematology Oncology. 2013 May 1; 35(4):289-298. doi:10.1097/MPH.0b013e31828d5e6a. PMC3659415.

27. Hurley CK, Woolfrey A, Wang T, Haagenson M, Umejiego J, Aljurf M, Askar M, Battiwalla M, Dehn J, Horan J, Oudshoorn M, PIdala J, Saber W, Turner V, Lee SJ, Spellman SR. The impact of HLA unidirectional mismatches on the outcome of myeloablative hematopoietic stem cell transplantation with unrelated donors. Blood. 2013 Jun 6; 121(23):4800-4806. doi:10.1182/blood-2013-01-480343. Epub 2013 MAY 1. PMC3674677.

28. McCarthy PL, Hahn T, Hassebroek A, Bredeson C, Gajewski J, Hale G, Isola L, Lazarus HM, Lee SJ, LeMaistre CF, Loberiza F, Maziarz RT, Rizzo JD, Joffe, Parsons S, Majhail NS. Trends in utilization and survival after autologous hematopoietic cell transplantation in North America from 1995 to 2005: Significant improvement in survival for lymphoma and myeloma during a period of increasing recipient age. Biology of Blood & Marrow Transplantation. 2013 Jul 1; 19(7):1116-1123. doi:10.1016/j.bbmt.2013.04.027. Epub 2013 May 6. PMC3694566.

29. Shamim Z, Spellman S, Haagenson M, Wang T, Lee SJ, Ryder LP, Müller K. Polymorphism in the Interleukin-7 receptor-alpha and outcome after allogeneic hematopoietic cell transplantation with matched unrelated donor. Scandinavian Journal of Immunology. 2013 Aug 1; 78(2):214-220. doi:10.1111/sji.12077. Epub 2013 MAY 21.

30. Hahn T, McCarthy PL Jr, Hassebroek A, Bredeson C, Gajeski JL, Hale GA, Isola LM, Lazarus HM, Lee SJ, Lemaistre CF, Loberiza F, Maziarz RT, Rizzo JD, Joffe S, Parsons S, Majhail NS. Significant Improvement in Survival After Allogeneic Hematopoietic Cell Transplantation During a Period of Significantly Increased Use, Older Recipient Age, and Use of Unrelated Donors. Journal of Clinical Oncology. 2013 Jul 1; 31(19):2437-2449. doi:10.1200/JCO.2012.46.6193. Epub 2013 May 28. PMC3691359.

31. Morishima Y, Kawase T, Malkki M, Morishima S, Spellman S, Kashiwase K, Kato S, Cesbron A, Tiercy J-M, Senitzer D, Velardi A, Petersdorf EW. Significance of Ethnicity in the Risk of Acute Graft-versus-Host Disease and Leukemia Relapse after Unrelated Donor Hematopoietic Stem Cell Transplantation. Biology of Blood & Marrow Transplantation. 2013 Aug 1; 19(8):1197-1203. doi:10.1016/j.bbmt.2013.05.020. Epub 2013 Jun 6.

32. Gadalla SM, Sales-Bonfim C, Carreras J, Alter BP, Antin JH, Ayas M, Bodhi P, Davis J, Davies SM, Deconinck E, Deeg HJ, Duerst RE, Fasth A, Ghavamzadeh A, Giri N, Goldman FD, Kolb EA, Krance R, Kurtzberg J, Leung WH, Srivastava A, Or R, Richman CM, Rosenberg PS, Sanchez de Toledo Codina J, Shennoy S, Socié G, Tolar J, Williams KM, Eapen M, Savage SA. Outcomes of allogeneic hematopoietic cell

transplant in patients with dyskeratosis congenita. Biology of Blood & Marrow Transplantation. 2013 Aug 1; 19(8):1238-1243. doi:10.1016/j.bbmt.2013.05.021. Epub 2013 Jun 8. PMC3736557.

33. Isobe N, Gourraud PA, Harbo HF, Caillier SJ, Santaniello A, Khankhanian P, Maiers M, Spellman S, Cereb N, Yang S, Pando MJ, Piccio L, Cross AH, De Jager PL, Cree BA, Hauser SL, Oksenberg JR. Genetic risk variants in African Americans with multiple sclerosis. Neurology. 2013 Jul 16; 81(3):219-227. doi:10.1212/WNL.0b013e31829bfe2f. Epub 2013 Jun 14. PMC3770164.

34. Koreth J, Pidala J, Perez WS, Deeg HJ, Garcia-Manero G, Malcovati L, Cazzola M, Park S, Itzykson R, Ades L, Fenaux P, Hellstrom-Lindberg E, Gale RP, Beach CL, Lee SJ, Horowitz MM, Greenberg PL, Tallman MS, Dispersio JF, Bunjes D, Weisdorf DJ, Cutler C. Role of Reduced-Intensity Conditioning Allogeneic Hematopoietic Stem-Cell Transplantation in older patients with De Novo Myelodysplastic Syndromes: an international collaborative decision analysis. Journal of Clinical Oncology. 2013 Jul 20; 31(21):2662-2670. doi:10.1200/JCO.2012.46.8652. Epub 2013 Jun 24.

35. Cornell RF, Hari P, Zhang MJ, Zhong X, Thompson J, Fenske TS, Horowitz MM, Komorowski R, Palmer J, Pasquini MC, Rizzo JD, Saber W, Thomas M, Drobyski WR. Divergent effects of novel immunomodulatory agents and cyclophosphamide on the risk of engraftment syndrome after autologous peripheral blood stem cell transplantation for multiple myeloma. Biology of Blood & Marrow Transplantation. 2013 Sep 1; 19(9):1368-1373. doi:10.1016/j.bbmt.2013.06.017. Epub 2013 Jun 24.

36. Gragert L, Madbouly A, Freeman J, Maiers M. Six-locus high resolution HLA haplotype frequencies derived from mixed-resolution DNA typing for the entire US donor registry. Hum Immunol. 2013 Oct;74(10):1313-20. doi: 10.1016/j.humimm.2013.06.025. Epub 2013 Jun 24.

37. Bochtler W, Maiers M, Bakker JN, Baier DM, Hofmann JA, Pingel J, Rist HG, Oudshoorn M, Marsh SG, Müller CR, Hurley CK. An update to the HLA Nomenclature Guidelines of the World Marrow Donor Association, 2012. Bone Marrow Transplant. 2013; doi: 10.1038/bmt.2013.93. [Epub ahead of print]

38. Maziarz RT, Wang Z, Zhang MJ, Bolwell BJ, Chen AI, Fenske TS, Freytes CO, Gale RP, Gibson J, Hayes-Lattin BM, Holmberg L, Inwards DJ, Isola LM, Khoury HJ, Lewis VA, Maharaj D, Munker R, Phillips GL, Rizzieri DA, Rowlings PA, Saber W, Satwani P, Waller EK, Maloney DG, Montoto S, Laport GG, Vose JM, Lazarus HM, Hari PN. Autologous hematopoietic cell transplantation for non-Hodgkin lymphoma with secondary CNS involvement. British Journal of Haematology. 2013 Sep 1; 162(5):648-656. doi:10.1111/bjh.12451. Epub 2013 JUL 6. PMC3766698.

39. Saber W, Cutler CS, Nakamura R, Zhang MJ, Atallah E, Rizzo JD, Maziarz RT, Cortes J, Kalaycio ME, Horowitz MM. Impact of donor source on hematopoietic cell

transplantation outcomes for patients with Myelodysplastic Syndromes (MDS). Blood. 2013 Sep 12; 122(11):1974-1982. doi:10.1182/blood-2013-04-496778. Epub 2013 JUL 11. PMC3772501.

40. Milius RP, Mack SJ, Hollenbach JA, Pollack J, Heuer ML, Gragert L, Spellman S, Guethlein LA, Trachtenberg EA, Cooley S, Bochtler W, Mueller CR, Robinson J, Marsh SGE, Maiers M. Genotype List String: a grammar for describing HLA and KIR genotyping results in a text string. Tissue Antigens. 2013 Aug 1; 82(2):106-112. doi:10.1111/tan.12150. Epub 2013 JUL 12. PMC3715123.

41. Smith SM, Burns LJ, van Besien K, Lerademacher J, He W, Fenske TS, Suzuki R, Hsu JW, Schouten HC, Hale GA, Holmberg LA, Sureda A, Freytes CO, Maziarz RT, Inwards DJ, Gale RP, Gross TG, Cairo MS, Costa LJ, Lazarus HM, Wiernik PH, Maharaj D, Laport GG, Montoto S, Hari PN. Hematopoietic stem cell transplantation for systemic mature T-cell non-Hodgkin lymphoma. Journal of Clinical Oncology. 2013 Sep 1; 31(25):3100-3109. Epub 2013 JUL 29. PMC3753702.

42. Eberhard HP, Madbouly AS, Gourraud PA, Balère ML, Feldmann U, Gragert L, Torres HM, Pingel J, Schmidt AH, Steiner D, van der Zanden HG, Oudshoorn M, Marsh SG, Maiers M, Müller CR. Comparative Validation of Computer Programs for Haplotype Frequency Estimation from Donor Registry Data.Tissue Antigens 2013;82(2):93-105. doi: 10.1111/tan.12160.

43. Locatelli F, Crotta A, Ruggeri A, Eapen M, Wagner JE, Macmillan ML, Zecca M, Kurtzberg J, Bonfim C, Vora A, Díaz de Heredia C, Teague L, Stein J, O'Brien TA, Bittencourt H, Madureira A, Strahm B, Peters C, Niemeyer C, Gluckman E, Rocha V. Analysis of risk factors influencing outcomes after cord-blood-transplantation in children with juvenile myelomonocytic leukemia. Blood. 2013 Sep 19; 122(12):2135-2141. doi:10.1182/blood-2013-03-491589. Epub 2013 Aug 7.

44. Costa LJ, Zhang MJ, Zhong X, Dispenzieri A, Lonial S, Krishnan A, Freytes C, Vesole D, Gale RP, Anderson K, Wirk B, Savani B, Waller EK, Schouten H, Lazarus H, Meehan K, Sharma M, Kamble R, Vij R, Kumar S, Nishihori T, Kindwall-Keller T, Saber W, Hari PN. Trends in Utilization and Outcomes of Autologous Transplantation as Early Therapy for Multiple Myeloma. Biology of Blood & Marrow Transplantation. . doi:10.1016/j.bbmt.2013.08.002. Epub 2013 AUG 9.

45. Kelly MJ, Horan JT, Alonzo TA, Eapen M, Gerbing RB, He W, Lange BJ, Parsons SK, Woods WG. Comparable survival for pediatric acute myeloid leukemia with poor-risk cytogenetics following chemotherapy, matched related donor, or unrelated donor transplantation. Pediatric Blood & Cancer. doi:10.1002/pbc.24739. Epub 2013 Aug 19.

46. Pidala J, Wang T, Haagenson M, Spellman SR, Askar M, Battiwalla M, Baxter-Lowe LA, Bitan M, Fernandez-Viña M, Gandhi M, Jakubowski AA, Maiers M, Marino SR, Marsh SG, Oudshoorn M, Palmer J, Prasad VK, Reddy V, Ringden O, Saber W,

Santarone S, Schultz KR, Setterholm M, Trachtenberg E, Turner EV, Woolfrey AE, Lee SJ, Anasetti C. Amino acid substitution at peptide- binding pockets of HLA class I molecules increases risk of severe acute GVHD and mortality. Blood. Epub 2013 Aug 27.

47. Bachanova V, Marks DI, Zhang MJ, Wang H, de Lima M, Aljurf MD, Arellano M, Artz AS, Bacher U, Cahn JY, Chen YB, Copelan EA, Drobyski WR, Gale RP, Greer JP, Gupta V, Hale GA, Kebriaei P, Lazarus HM, Lewis ID, Lewis VA, Liesveld JL, Litzow MR, Loren AW, Miller AM, Norkin M, Oran B, Pidala J, Rowe JM, Savani BN, Saber W, Vij R, Waller EK, Wiernik PH, Weisdorf DJ.. Ph+ ALL patients in first complete remission have similar survival after reduced intensity and myeloablative allotransplantation: Impact of imatinib and minimal residual disease. Leukemia. . doi:10.1038/leu.2013.253. Epub 2013 AUG 30.

48. Lee SJ, Storer B, Wang H, Lazarus HM, Waller EK, Isola LM, Klumpp TR, Umejiego JBC, Savani BN, Loren AW, Cairo MS, Camitta BM, Cutler CS, George B, Khoury HJ, Marks DI, Rizzieri DA, Copelan EA, Gupta V, Liesveld JL, Miller AM, Litzow MR, Schouten HC, Gale RP, Cahn J-Y, Weisdorf DJ. Providing personalized prognostic information for adult leukemia survivors. Biology of Blood & Marrow Transplantation. . doi:10.1016/j.bbmt.2013.08.013. Epub 2013 SEP 6.

49. Avigan D, Hari P, Battiwalla M, Bishop MR, Giralt SA, Hardy NM, Kröger N, Wayne AS, Hsu K. Proceedings from the National Cancer Institute's Second International Workshop on the Biology, Prevention, and Treatment of Relapse after Hematopoietic Stem Cell Transplantation: Part II. Autologous Transplantation - Novel Agents and Immunomodulatory Strategies. Biology of Blood & Marrow Transplantation. doi:10.1016/j.bbmt.2013.08.011. Epub 2013 Sep 6.

50. Marks DI, Ahn KW, Xiaobo Z, Appelbaum, Bachanova V, Barker JN, Brunstein CG, Gibson J, Kebriaei P, Lazarus HM, Olsson R, Perales, Pidala J, Savani B, Rocha V, Eapen M. Unrelated umbilical cord blood transplant for adult acute lymphoblastic leukemia in first and second complete remission: a comparison with allografts from adult unrelated donors. Haematologica. . doi:10.3324/haematol.2013.094193. Epub 2013 SEP 20.

51. Copelan EA, Hamilton BK, Avalos B, Ahn KW, Bolwell BJ, Zhu X, Aljurf M, van Besien K, Bredeson CN, Cahn J-Y, Costa LJ, de Lima M, Gale RP, Hale GA, Halter J, Hamadani M, Inamoto Y, Kamble RT, Litzow MR, Loren AW, Marks DI, Olavarria E, Roy V, Sabloff M, Savani BN, Seftel, M, Schouten HC, Ustun C, Waller EK, Weisdorf DJ, Wirk B, Horowitz MM, Arora M, Szer J, Cortes J, Kalaycio ME, Maziarz RT, Saber W. Better leukemia-free and overall survival in AML in first remission following cyclophosphamide in combination with busulfan compared to TBI. Blood. doi:10.1182/blood-2013-07-514448. Epub 2013 Sep 24.

52. Coleman CN, Case C Jr, et al. Medical planning and response for a nuclear detonation: a practical guide. Biosecur Bioterror. 2012;10(4):346-71. doi: 10.1089/bsp.2012.1025

53. Confer DL, Weisdorf D, Weinstock D, Case C, Chao N. Radiation Disasters: Role of the BMT Team. Biol Blood Marrow Transplant. 2012 Jan;18(1 Suppl):S189-92

54. World marrow donor association crisis response, business continuity, and disaster recovery guidelines" (Biology of Blood and Marrow Transplant. 2012 Dec; 18(12):1785-9. doi: 10.1016/j.bbmt.2012.08.006. Epub 2012 Sep 8).

55. Maiers M, Gragert L, Madbouly A, et al. 16(th) IHIW: global analysis of registry HLA haplotypes from 20 million individuals: report from the IHIW Registry Diversity Group.. Int J Immunogenet. 2013 Feb;40(1):66-71. doi: 10.1111/iji.12031.

56. Vierra-Green C, Roe D, Hou L, et al. Allele-level haplotype frequencies and pair wise linkage disequilibrium for 14 KIR loci in 506 European-American. PLoS One. 2012;7(11):e47491. doi: 10.1371/journal.pone.0047491. Epub 2012 Nov 5.

Abstracts

1. Koreth J, Pidala J, Perez WS, Deeg HJ, Garcia-Manero G, Malcovati L, Cazzola M, Park S, Itzykson R, Ades L, Fenaux P, Jädersten M, Hellstrom-Lindberg E, Gale RP, Beach CL, Greenberg PL, Tallman MS, DiPersio JF, Bunjes D, Weisdorf DJ, Cutler CS. A decision analysis of reduced-intensity conditioning allogeneic hematopoietic stem cell transplantation for older patients with de-novo myelodysplastic syndrome (MDS): early transplantation offers survival benefit in higher-risk MDS. Blood. 2011 118(21): Abstract O115.

2. Battiwalla M, Ellis K, Pavletic SZ, Akpek G, Hematti P, Klumpp TR, Maziarz RT, Savani BN, Aljurf M, Cairo MS, Drobyski WR, George B, Hahn T, Khera N, Litzow MR, Loren AW, Saber W, Arora M, Urbano-Ispizua A, Cutler CS, Flowers MED, Spellman S. HLA DR15 antigen status does not impact graft-versus-host disease or disease-free survival in HLA-matched sibling transplantation for hematologic malignancies. Blood. 2011 118(21): Abstract P3094.

3. Cook RJ, Wang Z, Arora M, Lazarus HM, Kasow KA, Champagne MA, Saber W, Van Besien KM, Hale G, Copelan EA, Elmongy M, Ueno, NT Horn BN, Slavin S, Stadtmauer EA. Is there a role for ASCT in patients with desmoplastic small round cell tumor of the peritoneum? Blood. 2011 118(21): Abstract P3092.

4. Hale G, Grupp, S Kasow K, Davies S, Hussein A, Childs R, Jodele S, Myers K, Stiff P, He W, Ahn KW, Copelan E, Lewis V, Bitan M, Cairo M, Horn B, Qayed M, Pulsipher M, Soni S, Chan K, Diaz MA, Kamani N, Kletze M, Shaw P, Bishop MR, Stadtmauer E, Ueno NT, Gonzalez VM, Lazarus H, Doyle J, Camitta B, Gale R, Sanders J, Wall D, Arora M, for the Solid Tumor and Pediatric Cancer Working Committees of the CIBMTR. Allogeneic hematopoietic cell transplantation (HCT) for neuroblastoma (NB): the CIBMTR experience. Blood. 2011 118(21): Abstract P3074.

5. Hahn T, McCarthy PL, Jr., Carreras J, Zhang MJ, Lazarus HM, Laport GG, Montoto S, Maloney DG, Hari P. A CIBMTR prognostic model for progression-free survival (PFS) after autologous hematopoietic cell transplantation (AHCT) for relapsed or refractory Hodgkin lymphoma (HL). Blood. 2011 118(21): Abstract O499.

6. Warlick ED, McClune B, Pedersen TL, Awn KW, Antin JH, Cahn JY, DeLima M, Gupta V, Marks DI, Bunjes D, DiPersio JF, Devine S, Weisdorf DJ. Older adults with chronic myelogenous leukemia (CML), during the tyrosine kinase inhibitor (TKI) era, can be successfully treated with reduced intensity conditioning (RIC) hematopoietic cell transplant (HCT) using sibling or unrelated donors: a Center for International Blood and Marrow Transplant Research (CIBMTR) analysis. Blood. 2011 118(21): Abstract O494.

7. Bacher U, Klyuchnikov E, Carreras J, Le-Rademacher J, Laport GG, Montoto S, , Maloney DG, Hari P. Conditioning intensity in allogeneic hematopoietic cell transplantation (alloHCT) for diffuse large B-cell lymphoma (DLBCL). Blood. 2011 118(21): Abstract O501.

8. Saad AA, Vesole DH, Le-Rademacher J, Zhong X, Dispenzieri A, Lonial S, Milone GA, Hari P. Second autologous transplants for multiple myeloma (MM) relapse after a prior autologous transplant (AHCT) – a report from the Center for International Blood and Marrow Transplant Research (CIBMTR). Blood. 2011 118(21): Abstract O504.

9. Freytes CO, Vesole DH, Zhong X, Le-Rademacher J, Dispenzieri A, Lonial S, Milone G, Hari P. Second transplants in relapsed multiple myeloma (MM): autologous (AHCT) versus non-myeloablative/reduced intensity (NST/RIC) allogeneic transplantation (AlloHCT). Blood. 2011 118(21): Abstract O824.

10. Ayas M, Le-Rademacher J, Deeg HJ, Gale RP, Davies SM, Bajwa RPS, Battiwalla M, Slavin S, Camitta B, Bierings MB, Harris RE, Olsson R, Wirk B, George B, Bonfim C, Saber W. Results of allogeneic hematopoietic cell transplantation in persons with Fanconi anemia and pretransplant cytogenetic abnormalities, myelodysplastic syndrome, or acute leukemia. Blood. 2011 118(21): Abstract O838.

11. McClune B, Pedersen TL, Ahn KW, Warlick ED, Pidala J, Waller EK, Rizzo JD, Cairo MS, Woolfrey A, Artz A, Lazarus HM, Weisdorf DJ. Reduced intensity or non-ablative hematopoietic cell transplantation in older patients with non-Hodgkin lymphoma (NHL): encouraging survival for patients ≥55 years. Blood. 2011 118(21): Abstract O1015.

12. Weisdorf DJ, Zhang MJ, Arora M, Rizzo JD, Horowitz MM, Eapen M. Graft-versus-host disease (GVHD) induced graft-versus-leukemia (GVL) effect: more impact on later relapse and disease-free survival following reduced intensity conditioning. Blood. 2011 118(21): Abstract O1014.

13. Eckrich MJ, Ahn KW, Wang Z, Deeg HJ, Horowitz MM, Eapen M. Effect of race on outcomes after allogeneic hematopoietic cell transplantation for severe Aplastic Anemia. Blood. 2011 118(21): Abstract O1020.

14. Leis J, Sabloff M, Sobecks R, Maziarz R, Ahn KW, Zhu X, Kalaycio M, Cortes J, Saber W on behalf of the CIBMTR Chronic Leukemia Working Committee. Outcomes of allogeneic hematopoietic cell transplantation (HCT) in chronic lymphocytic leukemia (CLL): impact of myeloablative (MA) vs. reduced-intensity conditioning (RIC) regimens, and impact of total body irradiation (TBI)-based MA versus chemotherapy (CT)-based MA conditioning. Biology of Blood and Marrow Transplantation 2012; 18(2) [Suppl 2]: P175.

15. Bredeson C, Burkart J, Zhu X, Sun Y, LeRademacher J, Pasquini M, Armstrong E, Rizzo JD, Kato K. Chimerism testing with reduced intensity intravenous Busulfan-based conditioning regimens: once is enough. Biology of Blood and Marrow Transplantation 2012; 18(2) [Suppl 2]: P182.

16. Bredeson C, Burkart J, Sun Y, Zhu X, LeRademacher J, Rizzo JD, Armstrong E, Pasquini M, Kato K. Dose, schedule and PK practices with IV busulfan-based conditioning regimens in a non-inferiority trial: heterogenous practices but low VOD and TRM. Biology of Blood and Marrow Transplantation 2012; 18(2) [Suppl 2]: P208.

17. Pederson KA, Rizzo JD, Hahn T, Lee SJ, McCarthy PL, Ammi MS, Denzen EM, Drexler R, Flesch SM, James H, Omondi NA, Pedersen TL, Murphy EA, Majhail NS. Patient and Family Out-of-Pocket Costs of Allogeneic Hematopoietic Cell Transplantation (HCT): A Pilot Study. Biology of Blood and Marrow Transplantation 2012; 18(2) [Suppl 2]: O211.

18. Tomblyn M, Trifilio S, Chen M, Klein J, Boeckh M, Gea-Banacloche J, Szabolcs P, Bennett C, on behalf of the CIBMTR Infection and Immune Reconstitution Working Committee. Risk Factors and Outcomes in patients with Atypical Mold Infection (AMI)following Allogeneic Hematopoietic Cell Transplantation (HCT): A CIBMTR Analysis from the Infection and Immune Reconstitution Working Committee. Biology of Blood and Marrow Transplantation 2012; 18(2) [Suppl 2]: O261.

19. Hong S, Barker C, John P Klein JP1, Peter Shaw P, Bredeson C, Angelina A, Rowlings P, Cahn JY, Kharfan-Dabaja M, Aljurf M, Szer J, Wood WA, Ahmed I, Gomez-Almaguer D, Atsuta Y, Pasquini MC and on behalf of the CIBMTR International Studies Committee. Trends in Utilization of Total Body Irradiation (TBI) Prior to

Hematopoietic Cell Transplantation (HCT) Worldwide. Biology of Blood and Marrow Transplantation 2012; 18(2) [Suppl 2]: O293.

20. Giglio F, Venstrom JM, Gooley TA, Gallagher MM, Hou L, Hurley CK, Lebedeva T, Noreen H, Rajalingam R, Reed EF, Vierra-Green C, Yu N, Haagenson M, Spellman S, Malkki M, Petersdorf E, Hsu KC. KIR3DL1/S1 and HLA-B alleles combine to influence unrelated hematopoietic stem cell transplantation (HSCT) outcomes. Biology of Blood and Marrow Transplantation 2012; 18(2) [Suppl 2]: O309.

21. Buchbinder D, Nugent D, Brazauskas R, Wang Z, Aljurf M, Cairo MS, Chow R, Duncan C, Eldjerou LK, Gupta V, Hale GA, Halter J, Hayes-LattinBM, Hsu JW, Jacobsohn DA, Kamble RT, Kasow KA, Lazarus HM, Mehta P, Myers KC, Parsons SK, Passweg JR, Pidala J, Reddy V, Sales-Bonfim CM, Savani BN, Seber A, Sorror ML, Steinberg A, Wood WA, Wall DA, Winiarski JH, Yu LC, Majhail NS. Late effects in hematopoietic cell transplant recipients with acquired severe Aplastic Anemia: a report from the Late Effects Working Committee of the Center for International Blood and Marrow Transplant Research (CIBMTR). Biology of Blood and Marrow Transplantation 2012; 18(2) [Suppl 2]: O316.

22. Majhail NS, Mau LW, Denzen E, Arneson TJ. Costs of hospitalization for hematopoietic cell transplantation (HCT) in the United States (U.S.): a pilot study using a large national commercial payor database. Biology of Blood and Marrow Transplantation 2012; 18(2) [Suppl 2]: O317.

23. Boyiadzis M, Klein JP, Arora M, Weisdorf DJ, Hassebroek A, Lee SJ, Flowers ME, Cutler CS, Urbano-Ispizua A, Antin JH, Bolwell BJ, Cahn JY, Cairo MS, Gale RP, Herzig RH, Isola LM, Jacobsohn DA, Jagasia MH, Klumpp TR, Petersdorf EW, Wingard JR, Horowitz MM, Pavletic SZ. Impact of chronic GVHD on late relapse, treatment related mortality and survival after allogeneic hematopoietic cell transplantation for hematological malignancies. Biology of Blood and Marrow Transplantation 2012; 18(2) [Suppl 2]: O436.

24. Aplenc R, Pasquini MC, Zhang MJ, Zhu X, McCarthy P, Ho VT, Cooke K, Sung L, Bunin N, On behalf of the CIBMTR Regimen Related Toxicity and Supportive Care Working Committee. Effects of body mass index (BMI) in children undergoing allogeneic bone marrow transplant (BMT) for hematologic malignancies. Biology of Blood and Marrow Transplantation 2012; 18(2) [Suppl 2]: O444.

25. Barker CA, Hong S, Klein JP, Shaw P, Bredeson C, Angelina A, Rowlings P, Cahn JY, Kharfan-Dabaja M, Aljurf M, Szer J, Wood WA, Ahmed I, Gomez Almaguer D, Atsuta Y, Sanz M, Hale G, Litzow M, Pasquini MC and on behalf of the CIBMTR International Studies Committee. Radiotherapeutic techniques in allogeneic hematopoietic cell transplant (HCT). Biology of Blood and Marrow Transplantation 2012; 18(2) [Suppl 2]: O448.

26. Milius RP, Shabo A, Pollack J, et al. HL7 implementation of silver standard principles for reporting HLA typing. Tissue Antigens 2012; 79(6): Abstract P279.

27. Robinson J, Pollack J, Walts A, et al. An XML export of the IMGT/HLA database. Tissue Antigens 2012; 79(6): Abstract P281.

28. Paunic V, Gragert L, Madbouly A, Freeman J, Maiers M. Shannon's entropy as a measure of in silico HLA typing ambiguity reduction using population haplotype frequencies. Tissue Antigens 2012; 79(6): Abstract P284.

29. Leahy N, Halagan M, Gragert L, Madbouly A, Maiers M. Automated HLA haplotype identification with typing inference from extended families. Tissue Antigens 2012; 79(6): Abstract P286.

30. Groeneweg M, Voorter CEM, Martin Maiers M, Tilanus MGJ. Analysis of extended polymorphisms In the exons of HLA and KIR genes: the polymorphic index of the peptide binding groove and beyond. Tissue Antigens 2012; 79(6): Abstract P290.

31. Gourraud PA, Cereb N, Yang SY, et al. Reshaping the MHC genetic contribution tomultiple sclerosis: an association study of high resolution HLA-A, HLA-B, HLA-C, HLA-DRB1, HLA-DQB1 in European and African American multiple sclerosis patients

32. Lazaro AM, Henry J, Xiao Y, Ng J, Hurley CK, Posch PE. Novel alleles, far from the finish line. Tissue Antigens 2012; 79(6): Abstract P321.

33. Roers B, Jones L, Heinke C, Fritch R, Setterholm M. Stored donor samples in the NMDP repository accelerate search activity timelines: use of stored samples saves 9 days for the patient searches. Presented at the WMDA International Donor Registry Conference, May 3-5, 2012, Sydney, Australia.

34. Dehn J, Kempenich J, Maiers M, Fernandez-Vina MA, Setterholm M. HLA-C DNA typed antigens frequently missed by prior serology. Presented at the WMDA International Donor Registry Conference, May 3-5, 2012, Sydney, Australia.

35. Kempenich J, Dehn J, Setterholm M. Inaccuracy of HLA-DRB1*16:08. Tissue Antigens 2012; 79(6): Abstract P41.

36. Marino SR, Lee SM, Haagenson M, Binkowski TA, Spellman S, Lee SJ, Karrison T. Identification of non-permissive amino acid substiutions associated with one year overall survival in hematopoetic stem cell transplantation. Tissue Antigens 2012; 79(6): Abstract P19.

37. Hurley CK, Wang T, Spellman SR, et al. Impact of HLA unidirectional mismatches on the outcome of unrelated donor hematopoietic stem cell transplantation. Tissue Antigens 2012; 79(6): Abstract O12.

38. Robinson J, Pollack J, Walts A, et al. An XML export of the IMGT/HLA database. Human Immunol 2012; 73(s): Abstract 189-P.

39. Gragert L, Maiers M, Smith S, et al. HLA haplotype frequencies and match rates for the Canadian Onematch Registry. Human Immunol 2012; 73(s): 93-P.

40. Al-Awwami M, Al-Jurf M, Al-Humidan H, et al. HLA haplotype frequencies in Saudi Arabia for design of a Saudi stem-cell registry. Human Immunol 2012; 73(s): 85-P.

41. Maiers M, Freeman J, Howard A, Chen DF. Prediction of HLA antigen matching probabilities for patients being considered for solid organ transplants. Human Immunol 2012; 73(s): 35-P.

42. Milius B, Schneider J, Heuer M, et al. Tools for implementation of silver standard principles for HLA typing. Human Immunol 2012; 73(s): Abstract 8-OR.

43. Ehab Atallah, Tanya Pedersen, Erica Warlick, Anne Dircks, Daniel Weisdorf, Mary Horowitz, J. Douglas Rizzo. The outcome of Hematopoietic Cell Transplantation (HCT) for Myelodysplastic Syndrome (MDS) in adults ≥ 65 years of age: first report of the Coverage with Evidence Development (CED) in medicare beneficiaries. Blood 2012. 120(21): Abstract P1983.

44. Hitzler JK, He W, Doyle JJ, et al. Outcome of transplantation for acute Leukemia in down syndrome. Blood 2012. 120(21): Abstract P1991.

45. Copelan EA, Hamilton BK, Ahn KW, et al. Lower transplant-related mortality and improved survival for patients with AML in first CR receiving BuCy compared to Cy/TBI as myeloablative preparation for allogeneic transplantation: a report from the Center for International Blood and Marrow Transplant Research (CIBMTR). Blood 2012. 120(21): Abstract O217."

46. Michael J. Kelly, John T. Horan, Todd A. Alonzo, Mary Eapen, Robert B. Gerbing, Wensheng He, Beverly J. Lange, Susan K. Parsons, and William G. Woods. Hematopoietic cell transplant versus chemotherapy as consolidation treatment for pediatric AML with poor-risk cytogenetics. Blood 2012. 120(21): Abstract O127.

47. Susana R. Marino, Sang M Lee, T Andrew Binkowski, Michael D Haagenson, Martin Maiers, Stephen Spellman, Koen van Besien, Stephanie J Lee, Theodore Karrison, and Andrew Artz. Identification of high risk HLA Class I amino acid substitutions in hematopoietic stem cell transplantation Blood 2012. 120(21): Abstract P3050.

48. Wael Saber, Corey Cutler, Ryotaro Nakamura, Mei-Jie Zhang, Ehab Atallah, J. Douglas Rizzo, Richard T. Maziarz, Jorge E Cortes, Matt Kalaycio, and Mary M. Horowitz. Comparison of outcomes after related and unrelated hematopoietic cell transplantation in

adults with myelodysplastic syndromes: a report from the Center for International Blood and Marrow Transplant Research (CIBMTR). Blood 2012. 120(21): Abstract O355.

49. Fabio Giglio, Ted A. Gooley, Jeffrey M. Venstrom, Meighan M. Gallagher, LiHua Hou, Carolyn K. Hurley, Tatiana Lebedeva, Harriet Noreen, Raja Rajalingam, Elaine F. Reed, Neng Yu, Cynthia Vierra-Green, Michael Haagenson, Mari Malkki, Effie Petersdorf, Stephen Spellman, Katharine C. Hsu. Donor KIR3DL1 and HLA-B allotypes control leukemia relapse after allogeneic hematopoietic stem cell transplantation. Blood 2012. 120(21): Abstract O349.

50. Joseph Pidala, Tao Wang, Michael D Haagenson, Stephen Spellman, Medhat Askar, Minoo Battiwalla, Lee Ann Baxter-Lowe, Menachem Bitan, Marcelo Fernandez-Vina, Manish Gandhi, Ann A Jakubowski, Martin Maiers, Susana R Marino, Steven GE Marsh, Machteld Oudshoorn, Jeanne Palmer, Vinod K. Prasad, Vijay Reddy, Olle Ringden, Wael Saber, Stella Santarone, Kirk R. Schultz, Michelle Setterholm, Elizabeth Trachtenberg, Vicky Turner, Ann Woolfrey, Stephanie J Lee, and Claudio Anasetti. Amino acid substitution at peptide-binding pockets of HLA Class I molecules adversely impacts hematopoietic cell transplantation outcomes. Blood 2012. 120(21): Abstract O467.

51. Mehdi Hamadani, Wael Saber, Jeanette Carreras, Kwang Woo Ahn, Ginna Laport, Silvia Montoto, David Maloney and Hillard Lazarus. Impact of conditioning regimen intensity on the outcomes of allogeneic hematopoietic cell transplantation for refractory Grade-III Follicular (FL-III) and Diffuse Large B-Cell Lymphomas (DLBCL): a CIBMTR analysis. Blood 2012. 120(21): Abstract O473.

52. Vikas Gupta, Kwang W Ahn, Xiaochun Zhu, Zhenhuan Hu, Parameswaran Hari, Richard T. Maziarz, Jorge E Cortes, Matt E. Kalaycio, and Wael Saber. Lille scoring system rather than DIPSS is a better predictive of overall mortality after allogeneic Hematopoietic Cell Transplantation (HCT) for primary myelofibrosis using reduced intensity conditioning: a report from the Center for International Blood and Marrow Transplant Research (CIBMTR). Blood 2012. 120(21): Abstract O432.

53. Ravi Vij, Xiaobo Zhong, Mei-Jie Zhang, Sagar Lonial, Angela Dispenzieri, and Parameswaran Hari. Pre-transplant salvage therapy prior to Autologous Transplant (AHCT) in patients not responding to initial induction for Multiple Myeloma (MM) Blood 2012. 120(21): Abstract O597.

54. Girindra Raval, Anuj Mahindra, Xiaobo Zhong, Ruta Brazauskas, Robert Peter Gale, Nancy Brandenburg, Sagar Lonial, Amrita Krishnan, Angela Dispenzieri, and Parameswaran Hari. Second malignancies after Autologous Hematopoietic Cell Transplantation (AHCT) for Multiple Myeloma (MM): A Center for International Blood and Marrow Transplant Research (CIBMTR) Analysis Blood 2012. 120(21): Abstract O591.

55. Mohamed L. Sorror, Brent Logan, J.Douglas Rizzo, Kennneth Cooke, Philip L. McCarthy, Vincent T. Ho, Xiaochun Zhu, Barry Storer, and Marcelo Pasquini. Prospective Validation of the Predictive Power of the Hematopoietic Cell Transplantation Comorbidity Index (HCT-CI) for HCT Outcomes at US Transplant Centers: A Center for International Blood and Marrow Transplant Research (CIBMTR) Study. Blood 2012. 120(21): Abstract O733

56. Monica S Thakar, Brent R. Logan, Marcelo C. Pasquini, Philip L. McCarthy Jr., Vincent T Ho, Kenneth R. Cooke, Xiaochun Zhu, J. Douglas Rizzo, and Mohamed L. Sorror. The Hematopoietic Cell Transplantation Comorbidity Index (HCT-CI) can prospectively discriminate risks affecting overall survival in pediatric and adult patients with non-malignant diseases Blood 2012. 120(21): Abstract O737

57. Michael Eckrich, Jennifer Le-Rademacher, J. Douglas Rizzo, K. Scott Baker, Deepika Bhatla, David K. Buchbinder, Kenneth R. Cooke, Reggie Duerst, Andrew Gilman, Haydar Frangoul, Neena Kapoor, Nancy A. Kernan, Michael Verneris, Mary Eapen. The Effect of Transplant Center Characteristics On Survival After Pediatric Hematopoietic Cell Transplantation. Blood 2012. 120(21): Abstract O762.

58. Luciano J Costa, Xiaobo Zhong, Mei-Jie Zhang, Sagar Lonial, Amrita Krishnan, Angela Dispenzieri, and Parameswaran Hari. Trends in utilization and outcomes of Autologous Hematopoietic Cell Transplantation (AHCT) in the upfront management of patients with Multiple Myeloma: a CIBMTR analysis Blood 2012. 120(21): Abstract O596.

59. Anuj Mahindra, Ayman A Saad, Mei-Jie Zhang, Xiaobo Zhong, Angela Dispenzieri, Amrita Krishnan, Sagar Lonial, Marcelo C Pasquini, and Parameswaran Hari. Hematopoietic Cell Transplant Co-Morbidity Index (HCTCI) and Multiple Myeloma (MM) survival after Autologous Hematopoietic Cell Transplantation (AHCT) Blood 2012. 120(21): Abstract P4217.

60. Mehdi Hamadani, Wael Saber, Jeanette Carreras, Kwang Woo Ahn, Ginna Laport, Silvia Montoto, David Maloney, and Hillard Lazarus. Effect of graft source and transplant conditioning regimen intensity on the outcomes of allogeneic hematopoietic cell transplantation for refractory Mantle Cell Lymphoma (MCL): A CIBMTR Analysis. Blood 2012. 120(21): Abstract O815.

61. Marcelo C. Pasquini, Brent R. Logan, Vincent T Ho, Philip L. McCarthy Jr., Kenneth R. Cooke, J. Douglas Rizzo, Xiaochun Zhu, and Mohamed L. Sorror.Comorbidity Index (CI) in Autologous Hematopoietic Cell Transplantation (HCT) for malignant diseases: validation of the HCT-CI Blood 2012. 120(21): Abstract O814.

62. Bredeson C, Le-Rademacher J, Zhu X, et al. Improved Survival with Intravenous Busulfan (IV BU) Compared to Total Body Irradiation (TBI)-Based Myeloablative Conditioning Regimens: A CIBMTR Prospective Study. Biol Blood Marrow Transplant 2013; 19(2): s111. Abtract 4.

63. Sorensen S, Renner R. The Benefits of Metadata Analysis and Form Question Harmonization. Biol Blood Marrow Transplant 2013; 19(2): s277. Abtract 335.

64. Kollman C, Klein JP, Spellman SR, et al. The Effect of Donor Characteristics On Graft Vs. Host Disease (GVHD) and Survival After Unrelated DonorTransplantation for Hematologic Malignancy. Biol Blood Marrow Transplant 2013; 19(2): s146. Abtract 67.

65. Barker JN, Fei M, Perez W, et al. Perez Results of a Prospective Multi-Center Myeloablative Double-Unit Cord Blood Transplantation Trial in Adult Patients With Acute Leukemia and Myelodysplasia (submitted on behalf of the RCI BMT 05-DCB Protocol Team). Biol Blood Marrow Transplant 2013; 19(2): s144. Abtract 64.

66. Bachanova V, Marks D, Zhang, MJ, et al. Allogeneic Transplantation for Ph+ Acute Lymphoblastic Leukemia (ALL): Impact of Conditioning Intensity,Tyrosine Kinase Inhibitors (TKI) and Minimal Residual Disease (MRD). Biol Blood Marrow Transplant 2013; 19(2): s223. Abtract 222.

67. Wirk B, Burns L, Fenske T, et al. Clinical Outcomes of Hematopoietic Cell Transplantation in Patients with Diffuse Large B Cell Lymphoma Transformed From Follicular Lymphoma. Biol Blood Marrow Transplant 2013; 19(2): s157. Abtract 86.

68. Xia C, Zhong X, Binod D, et al. Plerixafor Overcomes the Adverse Effect of Diabetes on Hematopoietic Progenitor Cell Mobilization. Biol Blood Marrow Transplant 2013; 19(2): s192. Abtract 158.

69. Chen M, McLeod A, Maziarz RT, et al. Outcomes of Allogeneic HSCT for Patients with Hematologic Malignancies (AML, ALL, MDS, CML) with and without Pre-Existing Fungal Infections: A CIBMTR Study. Biol Blood Marrow Transplant 2013; 19(2): s124. Abtract 29.

70. Hermanson J, Dehn J, Kempenich J, Miller JP, Navarro W, Setterholm M. Young Male Donors Provide the Best Chance of Meeting Requested Cell Dose for PBSC and Bone Marrow Transplantation. Biol Blood Marrow Transplant 2013; 19(2): s117. Abtract 16.

71. Fernandez-Vina MA, Wang T, Lee SJ,e t al. Mismatches for HLA-C*03:03/03:04 may be better tolerated than other mismatches in unrelated donor hematopoietic stem cell transplantation. Tissue Antigens 2013; 81(s1): Abstact O69.

72. Gragert, Stephanie DiPrima S, Albrecht M, et al. Amino acid and sequence feature variant type (SFVT) assignment by multiple imputation for HLA disease association studies on registry data. Tissue Antigens 2013; 81(s1): Abstact O49.

73. Freeman JL, Madbouly A, Brady CK, Leahy N, Maiers M. Modeling non-inherited maternal antigen registry match rates and effective inventory size increase. Tissue Antigens 2013; 81(s1): Abstact O16.

74. Albrecht M, Chatterjee S, Schneider S, et al. Copula transformation applied to haplotype frequency estimation: modeling high-resolution frequencies via regression of lower level frequency components. Tissue Antigens 2013; 81(s1): Abstact O18.

75. Ehrenberg A, Maiers M, Gourraud PA, et al. Comparison of matching potential for haplobank of induced pluripotent stem cell lines in various ancestry backgrounds: a call for international collaboration. Tissue Antigens 2013; 81(s1): Abstract P108.

76. Maiers M , Dehn J, Malmberg C, Oudshoorn M, Fernandez-Vina MA, Fleischhauer K. Use of a neural network to predict t-cell epitope group assignments for all HLA-DPB1 alleles. Tissue Antigens 2013; 81(s1): Abstract P156.

77. The GL service: web service to exchange GL string encoded HLA genotypes with complete and accurate allele and genotype ambiguity. Milius RP, Heuer M, Schneider J, et al. Tissue Antigens 2013; 81(s1): Abstract P155.

78. Roelen DL, de Vaal Y, Vierra-Green, et al. HLA mismatches that are identical for the antigen recognition site may have functional consequences: the DRB1*1401/1454 study. Tissue Antigens 2013; 81(s1): Abstract O32.

79. Hollenbach JA, Salamon H, Yamaguchi K, Maiers M, Mack SJ. Toolkit for immunogenomic data exchange and storage (TIDES). Tissue Antigens 2013; 81(s1): Abstract P157.

80. Ringden O, Brazauskas R, Wang Z, et al. Second solid cancers in patients treated with allogeneic haematopoietic cell transplantation using reduced intensity/non-myeloablative conditioning regimens: a Center of International Blood and Marrow Tranplantation Research study. Bone Marrow Transplant 2013; 48(s2): Abstract O375.

81. Pasquini M, Le-Rademacher J, Kato K, et al. Comparison of myeloablative intravenous busulfan with cyclophosphamide (BuCy) of fludarabine (BuFlu) prior to haematopoietic cell transplantation (HCT) for myeloid malignancies. Bone Marrow Transplant 2013; 48(s2): Abstract O379.

82. Switzer G, Bruce J, Myaskovsky, et al. Race/ethnicity is associated with donation experiences of US-based HSC donors. Bone Marrow Transplant 2013; 48(s2): Abstract O176.

83. Ruggeri A, Eapen M. Tucunduva L, et al. Changing trends of umbilical cord blood transplants for haematological malignancies in patients older than 50 years: a Eurocord-CIBMTR study. Bone Marrow Transplant 2013; 48(s2): Abstract O384.

84. Gragert L, DiPrima S, Albrecht M, et al. A novel multiple imputation method for uncovering HLA disease associations using unrelated donor registry databases. Bone Marrow Transplant 2013; 48(s2): Abstract P623.

85. Beduhn E, et al., Deletion of unconfirmed rare alleles, C*03:12 and C*15:20. Poster presentation at the 2012 ASHI Meetings. Supplemental Poster abstract 140-P Oct. 2012. Human Immunology, Volume 73, Supplement, October 2012, Page 137.

86. Kempenich JH, et al., HLA-A,B only typed donors: an untapped resource. Poster presentation at the 2012 ASHI Meetings. Supplemental Poster abstract 154-P Oct. 2012. Human Immunology, Volume 73, Supplement, October 2012, Page 145.